NUTRITIONAL AND NONNUTRITIONAL COMPONENTS OF DEMAND FOR FOOD

By

Jagadev N. Bagali

A DISSERTATION PRESENTED TO THE GRADUATE COUNCIL OF
THE UNIVERSITY OF FLORIDA
IN PARTIAL FULFILLMENT OF THE REQUIREMENTS FOR THE
DEGREE OF DOCTOR OF PHILOSOPHY

UNIVERSITY OF FLORIDA

1975

ACKNOWLEDGEMENTS

The author wishes to acknowledge the help and guidance of his major advisor Dr. A.A. Prato in the planning and analysis stages of this study and for his continued assistance after leaving the University of Florida.

To Dr. Leo Polopolus, the author is exceedingly grateful for inspiration and encouragement given at a time when the author was discouraged, for his assistance in arranging for his family to join him in Gainesville, and for his assistance in the dissertation research.

Dr. W.W. McPherson was very helpful, especially during the writing phases of the dissertation project. For his assistance, the author is very grateful.

The author also wishes to thank Dr. J.R. Vernon of the Economics Department and Dr. Howard Appledorf of the Food Science Department for their help as members of his supervisory committee. The author extends his appreciation to Dr. R.C. Littell of the Statistical Unit of the Institute of Food and Agricultural Sciences for his help in computer programming.

The author is very grateful for the help and guidance of Dr. M.R. Langham, especially during the first year of the author's graduate study in the Food and Resource Economics Department. At a

time when everything was strange and difficult in a new country and culture, Dr. Langham's mature advice and friendly treatment enabled the author to overcome many difficulties. Also thanks to Dr. K.R. Teffertiller, who was Chairman of the Food and Resource Economics Department when the author was granted financial assistance to enter graduate study in September, 1970.

To the other members of the faculty, staff, and graduate students in Food and Resource Economics, the author is very grateful for their assistance and special efforts to make his stay in Gainesville a happy one. Thanks are expressed to the secretaries who typed drafts of the dissertation and especially to Mrs. Scheffer for typing the final edition.

Finally, the understanding and sacrifice of the author's wife, Laxmi, during these years of graduate study are sincerely appreciated.

TABLE OF CONTENTS

Page

Page

LIST OF TABLES

Table | Page

LIST OF FIGURES

Abstract of Dissertation Presented to the Graduate Council of the University of Florida in Partial Fulfillment of the Requirements for the Degree of Doctor of Philosophy

NUTRITIONAL AND NONNUTRITIONAL COMPONENTS OF DEMAND FOR FOOD

By

Jagadev N. Bagali

June, 1975

Chairman: A.A. Prato
Co-Chairman: Leo Polopolus
Major Department: Food and Resource Economics

Until recently, nutritional considerations were mainly in the province of professional or clinical nutritionists. Attempts to understand the multidimensional nature and scope of nutritional problems are becoming more common. The present study represents one such attempt. Food purchase behavior is considered within a context that is neither purely economic behavior as found in traditional demand theory nor purely ecotechnical as found in Lancaster's (1966, 1971) "new" theory. The factors affecting food demand are categorized as economic, namely prices and incomes, nutritional or biogenic, and nonnutritional or social and psychogenic. A model that analytically decomposes the food demand vector into nutritional and nonnutritional components was developed within a framework of the traditional approach. Because of the universal and objective nature of nutritional factors, the nutritional component was assumed to be deterministic and to form an addi-

tive component with the nonnutritional component, which was estimated statistically.

The first objective was to develop a method for measuring the nutritional and nonnutritional components of demand for 42 meat products. Estimations were made of equations which portrayed a linear expenditure system for 12 region-urbanization consumer groups of the United States, as well as a regression model for the nation as a whole.

The second objective was to compare the nonnutritional component of different consumer groups. This was accomplished by computing β-coefficients of the linear expenditure system and the expenditure elasticities for 12 region-urbanization groups of households and their aggregates.

The third objective was to further analyze the nonnutritional component by determining the effects of economic factors and noneconomic characteristics of households on the nonnutritional component of the demand for food. This was accomplished by the use of a covariance model.

The empirical evidence supports three hypotheses, i.e., nutritional inefficiency exists, nutritional and nonnutritional components are competitive, and increased food expenditures augment the influence of nonnutritional factors. These findings cast doubt on the appropriateness of conventional income solutions to nutritional problems. The results do not support the belief that higher income or food expenditure necessarily leads to nutritional efficiency or improvement.

The results have important policy implications for nutritional education. This study suggests that foods can be classified into three categories: normal foods that are nonnutritionally superior in the

sense they are overconsumed; inferior foods that are nonnutritionally inferior in the sense that they are underconsumed, and neutral foods that are neither overconsumed nor underconsumed. The implication is that nutritional improvement policies should be directed mainly to normal and inferior foods. Various possibilities for nutritional improvement by reducing the nonnutritional component were discussed.

CHAPTER I

PROBLEM, OBJECTIVES, AND HYPOTHESES

Problem

The problem of malnutrition and its effects on physical growth and mental development cuts across many disciplines and requires an holistic approach to synthesize available information and existing methods of several fields such as nutrition, medicine, psychology, anthropology, sociology, biochemistry, and economics. Evidence on the possible consequences of nutritional deficiencies has been suggestive but not always conclusive. Until recently, nutritional considerations were mainly in the province of professional or clinical nutritionists. Attempts to understand the multidimensional nature and scope of nutritional problems are slowly appearing. The present study is one of these attempts. Social scientists, particularly economists, should be able to assist in synthesizing knowledge about food by (a) providing an understanding of malnutrition in its psychosociocultural and economic environment, (b) formulating and executing pilot studies, and (c) designing campaigns to implement those programs that survive the tests of feasibility. Nutritional potentials in any country depend on factors other than food production. Changes in distribution and transportation systems and in international trade will alter the nutrition potential. Nutrition potential also depends on demand patterns. The traditional economic approach to nutrition problems fails to consider

other dimensions of nutrition, which include the food mores and all the noneconomic and nonnutritional aspects of consumer behavior that stand between the availability of nutrients and their actual intake. Nonnutritional factors need explicit consideration if the expanding supply of nutrients is to find its way into people's diets. In other words, the expansion of nutrient intake depends on both the nutritional and the nonnutritional structure of the effective demand for food products.

A fundamental and important problem in understanding and explaining human behavior is how to isolate personal preferences from scientific facts. This problem surely exists in the case of food purchase behavior. Broadly, the problem considered in this study is to isolate the nonnutritional component of the demand for food from the nutritional component.

Objectives

The objectives of this study are (a) to develop a method for measuring the nutritional and nonnutritional components of demand for selected food products; (b) to compare the nonnutritional demand structure of these products among different consumer groups; (c) to determine how household characteristics, particularly income, regional and residential characteristics affect the nonnutritional component of the demand for food. To achieve these objectives, one needs a framework to explain food purchase behavior that accounts for all the complex factors underlying food consumption. A simplification of the complex problem of food consumption becomes a necessity. First, there is the need to simplify the complex environment

of nutrition by categorizing the factors that underlie food demand. Second, there is the need to simplify the role of the factors that influence the demand for food. Throughout the present study, emphasis is placed on improving the explanation of food purchasing behavior rather than the development of sophisticated methodology. There is a need to simplify the problem in order to reduce it to manageable terms and to abstract from irrelevant variables, but the analysis may be faulty if it is not based on an adequately integrated and realistic conception of the problem. The multidimensional nature of food purchase behavior necessitates a broad spectrum of field research on nutrition and on different groups of people. Only in this way can sufficient familiarity and understanding of the problem be gained and pragmatic approaches made to realistic solutions to problems. Simplification of the complexities is an aid to problem solving and does not necessarily reflect total reality.

Simplification of Factors

The first category of factors includes the economic variables of prices and incomes or purchasing power. Changes in prices and income may not have identical effects on the quantity of the nutritional compared with the nonnutritional component of food demanded. Economic factors are sometimes less important in consumer behavior than generally assumed in traditional demand theory. This is true even for low income groups in developing countries. Consumers with budgets insufficient to meet the expenses of staple food sometimes spend a considerable part of their incomes for processed foods at prices higher than those for nonprocessed foods. For example, a

West Bengal study [Roy, 1968] reports a large volume of sales of processed baby foods at prices much higher than that of cow's milk. Soft drink consumption by low income groups is another world-wide example of noneconomical consumer behavior with respect to nutrition. This kind of noneconomical consumer behavior demonstrates that economic factors, however important they may be, are far from being the only factors involved in food purchases. Increased purchasing power may or may not be a necessary condition for nutritional improvement. It is certainly not a sufficient condition without adequate nutritional education. Growth in per capita income has failed to solve many socio-economic problems. Economic development that increases and/or redistributes income can only be a necessary condition for nutritional improvement. Increased purchasing power must be accompanied by increases in quantities of nutritious foods and by desired changes in food consumption. Initially, the major concern of peoples of developing countries is how to obtain enough food, but that of peoples of developed countries is how to make food selections that meet healthful nutritional standards. So the problem in developing countries is one of economic growth and distribution in general and of food consumption in particular. In developed countries it is a question of improving food buying and eating habits. Given economic growth, any nutritional improvement program has to take two forms: (a) income distribution either in cash or in kind that maintains minimum incomes at levels sufficient for achieving adequate diets; (b) expenditure shifts by individuals from nutritionally poor to nutritionally rich foods.

The second category of factors includes those variables that make up the physiological or nutritional needs, namely, survival,

maintenance, and growth. Food nutrients supply chemical substances needed for survival, maintenance, and growth of organisms. The basic nutrients include calories, proteins, vitamins, and minerals. Food and nutritional scientists attempt to explain the effects of food intake on the internal ecology of the organism and its consequent implications for physical and mental health. These effects are extremely complex since the internal ecosystem consists of very intricate interrelationships and chain reactions that disturb the equilibrium of the organic system. Any deficiencies, excesses, or imbalances of nutrients ingested adversely affect the system. Recently, a great deal of attention has been given to the study of interrelationships that exist among the nutrients and between nutrients and heredity. The importance of an optimum ratio of one nutrient to another, e.g., calcium to phosphate, sodium to potassium, has been emphasized. Thus, in establishing dietary standards by national and international nutritional organizations, the underlying philosophy is based on providing (a) desirable or optimum nutrition which can be viewed as a physiological state in which any alteration cannot increase human well-being; (b) minimum nutritional requirements or allowances (on a physiological basis) below which clinical symptoms of nutritional deficiency develop; (c) desirable nutrient intake adequate for an "average man" defined in terms of occupation, age, climate, and other conditions. Unfortunately, optimal levels of nutrient intake are more difficult to define than are minimum requirements. Establishment of any criterion is complicated by the fact that every human being has some capacity for successful adaptation to varying levels of nutrient intake. There is no complete agreement as to desirable nutrient intake,

and recommendations on dietary standards vary greatly among places and times. Canadian recommendations are based on the "minimum requirements," while those of the United Kingdom are based on an average man's requirements. The recommended dietary allowances (RDA's) of the United States are based on an "optimal nutrition" criterion.

The third category of so-called "acceptance" factors includes such items as flavor, texture, odor, appearance, taste, bulk, refreshment, convenience (including ease of preparation), religious prescriptions, status-giving, self-esteem, cultural, and aesthetic values — the whole range of subjective nonnutritional factors. Throughout this study the factors underlying food purchase behavior are referred to as economic, nutritional, and nonnutritional or social factors. If only economic and nutritional factors were important, man could achieve the required nutritional level with very few foods. However, due to nonnutritional factors, man has developed a great variety in his diet. The great diversity in food consumption patterns can be partly attributed to the great diversity of these nonnutritional factors. The reason for such diversity appears to be that the latent potentialities of a man, physical as well as mental, have a greater chance of emerging when his environment is diverse and stimulating. Featureless environments, i.e., drab, uniform, and narrow ranges of life experience, cripple intellectual growth [Dubos, 1969]. Crippling of intellectual growth can be acute with respect to the food environment. Diversity of diet has been more important than mere economic efficiency in general and nutritional efficiency in particular. Though the first and most important attitude toward food is nourishment and nutritional value, eating is not merely a fueling operation of the human

(biological) engine. Man is a perpetually wanting animal. A want once satisfied soon becomes an indispensable need and the pattern repeats itself as new ones evolve. Maslow (1943) classifies human needs into physiological (or survival) and social elements. The idea behind his theory of human motivation is that a minimum satisfaction of a need is necessary before a person can move on to seek satisfaction of the next need in the following hierarchy of human needs [Lowenberg, 1968].

Number	Type of need	Physiological or social	Direction	
			normal	disastrous
1	survival	physiological	↓	↑
2	security	physiological & social		
3	love and belongingness	social		
4	esteem or status	social		
5	self-realization or self-actualization	social		
6	knowledge & understanding	social		

In the context of food and nutrition, this classification scheme corresponds to nutritional needs which are physiological and nonnutritional needs which are social. The word social here refers to all the psychosociocultural, and religious elements. The direction column implies that nutritional needs come first and nonnutritional needs second. Whatever their order, every human activity may be aimed at well-being, which is defined usually in terms of a feeling of security, contentment, and a sense of being at ease with one's self and with the surrounding environment.

An individual's food consumption patterns and the several aspects of his well-being are strongly related. The relation between

health and food consumption is rather well known. The relationships between emotional conditions and food consumption, the psychosocio-cultural and religious factors, are less well known.

An individual's emotional personality, i.e., how he views himself, his environment, and his role in it and his actions in coping with it, is reflected in his patterns of reaction to external stimuli. An individual who exhibits a reasonably adequate feeling about himself can be in good mental health. An individual's analysis of himself as a person is very important as it unconsciously influences all his decisions about appropriate conduct in any given situation. Decisions about eating are made continuously and the underlying motive has frequently been the unconscious enhancement of emotional well-being. Eating can be a highly emotional activity as it can result in pleasure and gratification or in anxiety or tension even though its primary function is to meet biological needs. What one eats and the environmental situation in which one eats will certainly affect one's well-being, though the degree of the effects may vary from person to person. Unfortunately, many persons are unaware of these effects. Food derives this kind of power from its many symbolic meanings, which have become a part of one's feelings. The relative importance of their meanings and their descriptions are dictated by past food consumption patterns. Details of these symbolic meanings are discussed by Gifft, Washbon and Harrison (1972). Human beings are complex creatures with many antithetical needs and drives in general and their food behavior in particular is the result in part of their attempts to satisfy some emotional needs. These emotional needs underly the nonnutritional component of food demands. Nutritional elements of food are essential for

physiological health and biological well-being, while the nonnutritional elements are necessary for emotional well-being. Interaction between the nutritional and the nonnutritional elements is possible, but this interaction is not taken into account in the present study.

Hypotheses

In the past, nutritionists have depended on nutrition education to improve the nutritional status of people. Their basic premise was that a considerable reduction in nutritional deficiencies could be achieved through behavioral changes within the limitations imposed by economic and other environmental or external factors. The traditional idea that malnutrition is due to low incomes may not be true. Evidence suggests that rich and poor people alike buy nutritionally poor foods in developed as well as in developing countries. In the case of the rich, the high level of living has its own features that are hazardous to well-being (nutritional or emotional). Whenever there are many varieties of wholesome foods and appropriate choices are economically feasible as they are in affluent societies, the nonnutritional factors tend to become dominant motives in food selection so that capriciousness often characterizes food behavior. Higher incomes give rise to higher food expenditures which in turn give rise to higher discretionary (or residual) expenditure. These dominant nonnutritional factors have an important influence on consumer expenditures. They work in a direction opposite to nutritional factors. If both nutritional and nonnutritional forces worked in the same direction, then the nutritional problem would be purely economic. Higher incomes or lower prices would invariably mean better nutrition.

The case of the poor is somewhat different. Poor families who feel deprived in other ways (in nonfood pleasures) may choose to compensate by buying those foods which have higher nonnutritional or social qualities but lower nutritional qualities. In other words, aesthetic or psychic values obtained from less nutritious food choices constitute one of the few limited pleasures available to the poor consumer. For example, economic development of Punjab villagers has been most dramatic and has reached all socioeconomic classes, but nutritional status has not improved because increased income has driven these people to purchases of status-symbol [Berg, 1973]. So the poor try to achieve more nonnutritional values at the expense of less nutrition. This gives rise to some discretionary expenditure even at low income levels.

Based on these arguments and the assumption that all the three factors -- economic, nutritional and nonnutritional -- characterize consumers' food behavior, the following three hypotheses are formulated: (1) within the limitations imposed by economic factors, nutritional inefficiency exists in consumers' food purchase behavior; (2) the nutritional and the nonnutritional factors associated with food consumption are competitive; and (3) the importance of nonnutritional factors increases with respect to discretionary food expenditures.

These concepts can be quantified. With q as the actual (observed) consumption vector, p as the price vector, and m_f as total food expenditure, one can write q as

$$q = q^{(1)}(e,n) + q^{(2)}(e,s)$$

where e is a set of economic factors, n stands for nutritional factors,

s stands for social (nonnutritional) factors and $q^{(1)}$ and $q^{(2)}$ are, respectively, nutritional and nonnutritional components of q. Since nutritional factors are universal and objective, one can assume that the nutritional component $q^{(1)}$ is not subject to stochastic variation and it can be determined by some rational criterion. With $z = Bq$ as a desired nutrient vector, and $B = (b_{ij})$, b_{ij} being the amount of i^{th} nutrient in one unit of the j^{th} food as a consumption technology matrix, one can take $q^{(1)}$ to be a vector of foods such that it provides z more economically than q itself. That is $q^{(1)}$ satisfies $Bq^{(1)} = Bq$ and $p'q \geq p'q^{(1)}$ so that nutritional inefficiency in consumer food behavior is reflected in the discretionary expenditure $m_f - p'q^{(1)}$.

The first hypothesis, i.e., nutritional inefficiency exists in consumers' food purchases, implies that this discretionary expediture $m_f - p'q^{(1)}$ is expected to be greater than zero for almost all consumers. If consumers were purely "economic men" in real life and functioned only in terms of marginal utility of nutrition, they would have purely utilitarian attitudes toward food and thus would consume only $q^{(1)}$. Then $m_f - p'q^{(1)} = 0$, since $q - q^{(1)} = 0$. But nonnutritional factors have utility, so that in general $q - q^{(1)} = q^{(2)} \neq 0$. The second hypothesis, i.e., the nutritional and the nonnutritional factors associated with food consumption are competitive, means that a higher (lower) nutritional component is associated with a lower (higher) nonnutritional component for any food item. In other words, more (less) economically nutritious foods are likely to have negative (positive) nonnutritional components. If the i^{th} food is economically

nutritious, then $q_i^{(1)} > 0$ and is large, and s-factors push its consumption downward so that $q_i^{(2)} = q_i - q_i^{(1)} < 0$ and it is underconsumed from a nutritional viewpoint. If the i^{th} food is economically nonnutritious $q_i^{(1)} = 0$ and s-factors push its consumption upward so that $q_i^{(2)} = q_i > 0$ and it is overconsumed from a nutritional viewpoint.

If a sort of residual Engel curve is estimated, $e_i^{(2)} = \beta_i(m_f - p'q^{(1)})$ for the i^{th} food, where $e_i^{(2)} = p_i q_i^{(2)}$, it is expected to have a positive (negative) slope if the i^{th} food is less (more) nutritious. That is, b_i, the estimate of β_i will be positive for those foods which do not enter (or enter very infrequently in small quantity) the nutritional component $q^{(1)}$ and negative for those foods which enter $q^{(1)}$ frequently in large quantities.

The last hypothesis is that the importance of nonnutritional factors increases with respect to discretionary (or total food) expenditure. If the nonnutritional component, $e^{(2)}$, is expressed as a function of all nonnutritional factors including income or expenditure, namely $e_i^{(2)} = f(m_f - p'q^{(1)}, H_1^s, H_2^s; H_k^s)$, where H_i^s is the i^{th} nonnutritional factor, $i = 1, 2, \ldots k$, the hypothesis implies that

$$\frac{\partial e_i^{(2)}}{\partial m_f} \text{ or } \frac{\partial e_i^{(2)}}{\partial (m_f - p'q^{(1)})} \gtrless 0$$ according to whether food i is nonnutritious or nutritious. In other words, nutritional efficiency (inefficiency) decreases (increases) with increasing food expenditure.

Selection of Food Items and Data

The food items grouped under (a) meat, poultry and fish, (b) vegetables and fruits, and (c) milk, cream and cheese, account for

35 and 37 percent, 18 percent and 12 to 14 percent, respectively, of total household food expenditure in the United States [USDA, 1965]. The consumption technology matrix was available only for the meat, poultry and fish group. For this reason the analysis in the present study is limited to 42 food items included in this group. The spring sample of households was used because the spring consumption was found to be more representative of average annual U.S. food consumption and the size of the spring sample was three times that of any other quarter. A detailed description of the data is given in Chapter V.

CHAPTER II

THEORIES OF CONSUMER DEMAND

How to describe and explain consumer behavior in a realistic way is one of the oldest economic problems. Since everyone is a consumer, it is a most fascinating subject. In other words, consumption theory is a theory about ourselves. The literature is reviewed under the following headings: (a) "traditional approach," (b) "new approach," (c) "psychological approach," and (d) "neocardinal approach." The relevance of each of these approaches to the demand for food is discussed.

In the traditional approach, the consumer maximizes utility defined on the commodity space subject to his budget constraint. In the new approach, developed by Lancaster (1966, 1971), the consumer maximizes utility defined on the objective and measurable characteristics space subject to budget and consumption technology constraints. The technological, psychological, and neocardinal approaches are of recent origin.

Traditional Approach

Without going into the axioms of utility theory and their relevance and implications, the traditional model is

$$\text{Max: } U = u(q).$$

$$q \in G \quad \text{where}$$

$$G = [q \; / \; p'q \leq m, \; q \geq 0],$$

and p = price vector, q = quantity vector, and m = income. Considering only the equality sign in $p'q \leq m$, demand functions are derived from the first order conditions. The properties of demand functions are discussed below. With λ as the Langrange multiplier (marginal utility of money) and letting subscripts denote partial derivatives, first order conditions are $u_q = \lambda p$, and $p'q = m$ which when solved for q and λ yield: $q = q(p, m)$ and $\lambda = \lambda(p, m)$. The matrix of price slopes is

$$Q_p = \lambda U^{-1} - \lambda\lambda_m^{-1} q_m q'_m - q_m q' = \lambda \frac{(I-U^{-1}pp')}{p'U^{-1}p} U^{-1} - \frac{U^{-1} p q'}{p'U^{-1}p}$$

$$= \lambda(I-E)\, U^{-1} - \frac{U^{-1} p q'}{p'U^{-1}p} ,$$

where λU^{-1} is a matrix of specific substitution effects,

$- \lambda\lambda_m^{-1} q_m q'_m$ is a matrix of general substitution effects,

$-q_m q'$ is a matrix of income effects,

$$E = \frac{U^{-1} pp}{p\, U^{-1}p} .$$

I-E is the correction factor with respect to the specific effect which is caused by the budget restriction. The sum of the general and the specific substitution effects $(\lambda U^{-1} - \lambda\lambda_m^{-1} q_m q'_m)$ is commonly known as the Slutsky substitution matrix.

The nine forms of the demand functions which have been employed in empirical studies are listed in Bridge (1971), along with the three demand parameter constraints; namely, aggregation constraints, homogeneity constraints, and symmetry constraints. The choice of the form depends on the parameters to be estimated. Although these independent restrictions reduce considerably the number of parameters to be estimated, the number is still large for small samples. Additional assumptions of "direct utility," "indirect additivity," "almost additivity" and "neutral want satiation" have been suggested. These additional assumptions would place severe restrictions on the amount of complementarity and/or substitutability of commodities.

Within the traditional framework, four approaches to the estimation of demand functions have been used: specific utility, traditional theory constraints imposed on a specific form of demand function, total differentials, and separability.

The nine forms of demand functions listed by Bridge (1971) are in terms of the general utility function, $u = u(q)$, and general forms of coefficient matrices, such as H or H^*. In the specific utility approach the specific forms of the demand functions are derived by assuming a specific form for the utility function, such as the Stone-Geary utility function [Geary, 1949-50, and Stone, 1954], the exponential utility function [Tsujimura, 1960], indirect addilog function, and the Gossen function [Houthakker, 1960 and Tsujimura and Sato, 1964]. All of these utility functions are point-wise additive and thus restrict severely the amount of complementarity and substitution among commodities. As Houthakker

(1961) points out, the search for a satisfactory form of the utility function is worthwhile since it provides a sound and solid footing for empirical demand analysis. The Stone-Geary utility function is used in the present study.

In the second empirical approach, the form of the demand function is first specified and then the constraints of the traditional theory are imposed on the parameters. Examples are provided by Stone's (1954) and Powell's (1966) linear expenditure systems. It is important to note that this approach does not specify which parameters are to be treated as fixed and which parameters are to be estimated. Thus, there exists a wide range of possibilities for estimation compared to the utility specification approach. This flexibility of opportunities is exploited in the present study by first determining the nutrition component and then estimating the nonnutrition component. Both the Stone and Powell linear expenditure systems can be used. The remaining two approaches are discussed below but are not used in the present study.

In the third empirical approach, or Rotterdam School approach, the total differentials of the general form of demand functions, $q = q(p,m)$, are derived from the general utility function, $u = u(q)$, and are used in the so-called "Rotterdam School" approach of Theil and Barten [Theil, 1965, 1967, Barten, 1967, 1968, Barten and Turnovsky, 1966, and Parks, 1969]. This is an approximation model since it considers the tangent hyperplanes to the demand functions, $q = q(p,m)$, at each and every point of equilibrium. In addition, the additivity hypothesis can be imposed [Theil, 1971, sections:

7.5, 7.6, 7.7, 11.6 to 11.9 and 12.7]. In this approach, local group price indices will suffice for the local validity of the model. Goldberger (1967a, 1967b) has shown that, with the additional assumption of point-wise additivity and constant budget shares, a global model can be derived from the Stone-Geary utility function wherein total differentials need not be used.

In the fourth empirical approach, separability, various forms of separability are imposed on the utility function to simplify demand analysis [de Janvry, 1966]. Although traditional utility theory is of limited help in formulating a single commodity demand function, there have been attempts to estimate a complete system of demand functions by imposing all the restrictions of the theory.

The possibility of estimating a complete system of demand functions is certainly appealing and empirical attempts have given interesting results [Stone, 1954, Powell, 1966, Barten, 1964, and Johansen, 1969]. However there are limitations with a complete system. First, it is necessary to assume that conditions on individual behavior hold in the aggregate, e.g., symmetry of the Slutsky matrix. There is little empirical evidence to justify this assumption. Second, the choice of functional form is severely restricted. Practical considerations virtually require that the same functional form be used for each and every commodity. Such restrictions do not conform well with a priori expectations about behavior, nor are they satisfactory in single commodity studies. Third, there are severe restrictions on interrelatedness among commodities. Fourth, assumptions of various types of additivity

may be quite reasonable for aggregate commodities such as "food" or "clothing," but may be unreasonable for elementary commodities.

An important consideration is whether the traditional consumer theory yields any meaningful restrictions on demand functions for a "single" commodity. Unfortunately, the two restrictions, negativity of own price substitution effects and the zero degree homogeneity of demand functions, have very little practical value for single commodity studies with the exception of an inferior commodity in the case of the first restriction. The homogeneity restriction is not particularly useful for single commodity studies since all prices are seldom included with income. Single equation models (the demand for a single commodity), though less satisfactory from a theoretical point of view, have outperformed complete models in terms of explaining past experience and projecting future behavior.

The main weaknesses of traditional demand theory may be summarized in terms of eleven characteristics

(a) It is a static theory

(b) The number of goods is fixed, which is unrealistic as new goods are introduced and product qualities undergo changes. Ironmonger (1972) and Praag (1968) have attempted to account for these possibilities.

(c) The behavioral assumption that the consumer is capable of accounting for all commodities and their interdependences simultaneously is a superhuman requirement. Praag (1968) brands traditional theory as a theory of irrational rationality and proposes his neocardinal theory which he says is a theory of rational irrationality.

(d) Ordinality of theory makes it sterile. According to Praag (1968, p. IX), Frisch stated, "To me the idea that cardinal utility should be avoided in economics is completely sterile. It is derived from a very special and indeed narrow part of theory, viz. that of static equilibrium." Praag (1968) introduces cardinality in his theory.

(e) There are questions of what are these n commodities of the theory in the real world? In what way have corresponding quantity units and prices been defined? Are all these n commodities relevant for a consumer's decision at a particular period? Praag (1968) introduces a process to deal with a variable set of relevant commodities.

(f) It is not obvious that it is always possible to define or specify a utility function that yields specific forms of demand functions.

(g) It does not handle explanations of changes in consumer tastes, except as shifts in demand functions.

(h) Only subjective characteristics are considered. Objective characteristics, i.e., consumption technology, are omitted.

(i) It is a theory of "pure economic man" in the sense that it considers only economic factors -- prices and income as constraints on consumer behavior -- and ignores all the psychosociocultural and religious factors which are important for many commodities, especially food products.

(j) All commodities satisfy one single want -- happiness as measured by utility. The idea of separate wants, an intermediate stage between this one dominant want and commodities, is absent in the traditional theory. Originally, this feature was not absent. Marshall (1953) recognized separate wants and their distinction. In the mathematical treatment (for convenience) of consumer behavior by Pareto (1909), Fisher (1925), Hicks and Allen (1934), also Slutsky (1915), this distinction was dropped and commodities were invariably assumed to satisfy directly one dominant want -- utility. Because of this assumption, the phenomenon of substitution was more dominant than that of complementarity. Even so, why a new good, such as margarine, is a substitute for butter cannot be explained by the traditional theory. The technological theory can explain this substitution by saying that the structure of characteristics vector associated with margarine is very similar to that associated with butter in the consumption technology matrix. In other words, their intrinsic capacities to satisfy different wants are almost similar.

(k) In the traditional theory, substitution and complementary relationships among commodities are not given by the objective characteristics of the commodities (as in the new approach), but are rooted in the specific utility function of each individual consumer and are therefore expected to be different for different consumers. Therefore, nothing can be said about such relationships on an a priori basis.

New Approach

Consumption technology has a crucial role in the new approach to consumer theory by Lancaster (1966). In this model the consumer's decision-making process is analytically decomposed into two stages: (1) an efficient choice on the basis of consumption technology, and (2) an optimal choice on the basis of individual utility. Lancaster provides remedies for some of the conceptual shortcomings of the traditional theory. However, while some of the problems can now be solved in principle, the empirical possibilities have not been firmly established.

Since goods can be directly observed, the main purpose of any theory of consumer behavior should be to formulate economic laws in terms of quantities of goods consumed. Therefore, it is quite natural that in early models goods are assumed to be the direct source of utility and satisfaction for the consumer and that goods are the arguments of individual utility functions. Perhaps the major difference between the traditional theory and the new theories is in the following basic assumption. According to the new theory, the consumption of goods as such is not the goal of the consumer's activity but only the means to obtaining more basic needs, such as nutrition in case of food consumption, which become the real sources of satisfaction. Goods provide characteristics which become the arguments of the utility function.

In the new theory, the consumer has to solve the following optimization problem.

Maximize $U(z)$

s.t. $T(z,x) = 0$

$p'x \leq m,\ x \geq 0,$

where $T(z,x) = 0$ is the consumption technology relation and m is income.

$T(x,z)$ is a concave contoured function and is assumed to possess all the neoclassical properties of a transformation surface.

The new approach gives use to a new definition of a market. Traditionally, two consumers face the same market if both confront the same structure of prices. In the new theory, in addition to prices, consumers face the same consumption technology. Classical theory can be viewed as a special case of the new theory in two ways. First, it can be interpreted as a special case in the sense that all goods have one characteristic, i.e., utility. In the new theory, different characteristics can be considered as various aspects of satisfaction or as different facets of utility. Therefore, the new theory is a multidimensional generalization of a single valued function. Formally, suppose that T is a scalar-vector function instead of a vector-valued function and that the vector z has only a single component. If the conditions of "the implicit function theorem" are satisfied, one can write $T(z,x) = 0$ as $z-f(x) = 0$. By this transformation the new program is converted to the old one where the maximand now is $U(z) = U[f(x)]$. Second, the traditional analysis is a special case of the new model when there is a one-to-one correspondence between goods and characteristics. The richness of the new theory comes essentially from the possibility that there is more than one characteristic and that usually the number of goods is greater than the number of characteristics.

The effects of product changes, advertising, and innovation in consumer goods can be traced and analyzed in the framework of the new theory since the consumption technology and not the utility function is expected to be affected by these factors. As a substitute for butter, margarine is better than grease simply because the structure of its characteristics vector is closer to that of butter than to that of grease. Several applications of the new theory have been made. The "mean-variance approach" to portfolio selection analysis is one application. A second application is Becker's analysis (1965) of allocation of time between consumption and the labor market, using "leisure" as a factor affecting the consumption technology in contrast to traditional models of labor economics where leisure is an argument in the utility function. A third application is Chetty's study (1969) in which he measured "the nearness of near-moneys" by defining "moneyness" as a common characteristic of all the money assets. In a fourth application, Alcaly and Klevorick (1969) explained the phenomenon of judging quality by price as a rational behavior of consumer when the price itself is one of the characteristics of the good purchased.

The consumer problem can be interpreted as a problem of "activity analysis" as in production theory. The consumer problem is to maximize $U(z)$ subject to $z = By$, $x = Ay$, $p'x \leq m$, and $y \geq 0$, where y is a vector of activities and the pair of matrices (A,B) is the consumption technology. When A is a permutation of a diagonal matrix, one has the usual simple model discussed in detail in Lancaster (1971).

By so generalizing, it is possible to handle substitutional as well as complementary relationships among commodities on the basis of

objective properties of consumption technology. Phenomena such as "order of acquisition" or "universal" pattern of wealth, can be explained more naturally within this technology approach to consumer theory.

Perhaps the main deficiency which accompanies the new approach is that the characteristic vector z and the consumption technology matrix B cannot be observed directly as can the goods and price vectors x and p. This fact is an obstacle for the empirical application of this new theory. One way to overcome this difficulty is to use "factor analysis" in order to predict the "latent structure" of the consumption technology from the observed vector of goods, exactly in the same way that this technique has been used to discover the latent structure of personality components from observed scores of psychotechnical tests.

Lancaster (1971) assumes linear consumption technology for three reasons. First, the analysis can be simplified and the presentation made more convenient without loss of generality. Second, linearization is considered as a first approximation to the real world. Third, it permits the use of linear programming procedures to obtain deeper insight into the model. So, with linearization, $T(z,x) = 0$ becomes $z = Bx$ where B is the consumption technology matrix whose elements change only when technological change occurs in the economy or as a result of some innovation. This case is discussed further below.

In Lancaster's new approach to consumer behavior the main assumption is that goods per se are not desired by the consumers. It is the objective and measurable characteristics of goods that are desired

by consumers. The utility function is therefore defined on the characteristics space and not on the goods space as in traditional theory. The second assumption is that the r characteristics are related to n consumer goods ($n > r$ usually) by a linear (fixed) technology matrix $B = (b_{ij})$, where b_{ij} is the amount of the i^{th} characteristic in one unit of the j^{th} good; $i = 1, 2, \ldots, r$; $j = 1, 2, \ldots, n$. The consumption technology is given by $z = Bq$, where z is the vector of characteristics. The behavioral assumption is that the consumer maximizes his utility, $u = u(z)$, subject to $z \varepsilon K$ where K is the image of the budget set $G = [q/p'q \leq m,\ q \geq 0]$ in the characteristics space as given by consumption technology, $z = Bq$. That is, $K = (z/z = Bq,\ q \varepsilon G)$.

Based on these assumptions, Lancaster studies the general properties of the feasible set K, and their dependence on the consumption technology matrix B, price vector p, and income m. One result of Lancaster's approach used in the present study is that every $q^* \varepsilon E_G$ is a solution to the following cononical linear program:

$$\text{Min: } p'q$$

$$\text{s.t. } Bq = z^* \text{ for some } z^* \varepsilon E,$$

$$q \geq 0,$$

where E is the efficient frontier of K and $E_G = (q/Bq \varepsilon E,\ q \varepsilon G)$.

Lancaster explains this programming criterion as the chief analytical tool used to obtain an efficient "bundle" of goods for a given collection of characteristics. His criterion is used in the present study to isolate the nutrition component of the demand for food products. Lancaster also points out that traditional demand theory can be carried out entirely in terms of a "single representa-

tive consumer." By drawing a single representative set of indifference surfaces one can describe the type of behavior of any individual consumer or any aggregate of consumers. With Lancaster's approach a single consumer can never represent the market behavior when the number of goods exceeds the number of characteristics. There are different types of optima: vertex optima, edge optima, and facet optima. Since a consumer can at most consume r(<n) goods, an observed market situation in which all n goods are actually consumed cannot be explained by the behavior of a single representative consumer. This situation will not occur in the model used in the present study as $q_i^{(1)} = 0$ does not imply $q_i^{(2)} = 0$ for any i. (See Chapter V.)

The new theory has been very useful for an analysis of the demand for durable goods. So far, most of the models for durable goods are developed on an ad hoc basis. In case of foods (or other nondurable goods), many of the items are bought simultaneously and consumed. But it is not so with regard to durables. There seems to be some kind of degree of essentiality involved and, therefore, many researchers are interested in finding the so-called order of acquisition of durable goods. Traditional theory of consumption can neither satisfactorily explain why order relations exist nor suggest possible uses for such information. Models within the framework of the consumption technology approach which generates order relations in consumption from the efficient purchasing behavior have been developed in recent studies [Paroush, 1969]. Significant statistical evidence of the existence of orders of acquisition that appear to be universal and objective properties of an economy as a whole are found in recent studies. In Israel, the order of acquisition was found to be as follows: radio,

gas, range, refrigerator, washing machine, second radio, electric mixer, vacuum cleaner, car, and tape recorder [Paroush, 1969]. One can naturally expect that such order-relations in consumption spring from the similarities in consumption technologies rather than from similar tastes or utilities. Attempts have been made to explore the possibilities of applying the new theory, with a knowledge of order relations, in such fields as finance and marketing.

The new technological approach has provided a solid theoretical basis for investigation of order relations in general and order of acquisition in particular.

Traditional theory has practically nothing to say about new commodities. How to approach the analysis of new commodities is too important a factor to be ignored. Problems of handling changes in qualities or characteristics of existing commodities also occur. This matter is important both in food demand and in the demand for durables. The lack of consumer theory on these topics may be attributable to the relatively recent emergence of concern over new commodities and changes in the qualities of existing commodities. In the past, innovation and technological change were largely confined to the means of production rather than to the means of consumption. In other words, inventors' and innovators' main concern was how to produce existing commodities more efficiently and not how to produce efficient commodities. The emphasis on producing efficient goods has generated interest in the efficient consumption of available goods. Ironmonger (1972) has come up with a theory which examines, both theoretically and empirically, the importance of new commodities and their influence on the tastes and habits of consumers. Development of new commodities

and improvements of existing commodities are prominent features of today's consumer market in which consumers' tastes and habits are constantly undergoing change.

The main elements of Ironmonger's theory are

(a) Both in traditional theory and in Lancaster's theory there is only one want -- utility (as a function of goods in traditional theory and as a function of characteristics in Lancaster theory) which is maximized. This utility function defines consumer preferences. But in Ironmonger's theory, preordered wants define consumer preferences. These wants are related to goods via consumption technology, as are characteristics in Lancaster's theory.

(b) Both in traditional and in Lancaster theories, consumers' tastes and habits are reflected in their utility functions which are fixed. In Ironmonger's theory, they are reflected in changes in saturation levels of wants and in priorities among wants which are not fixed.

(c) In Ironmonger's theory, changes in product qualities and new commodities are reflected in changes in the consumption technology matrix. Thus, new commodities, changes in consumer tastes and preferences, and changes in product qualities are handled explicitly.

(d) Rational behavior in Lancaster theory is to maximize utility subject to both budget and consumption technology constraints, whereas in Ironmonger's theory the consumer maximizes his marginal want subject to a budget constraint and the constraints that the prior wants are fulfilled.

Ironmonger's work is in the framework of a technological or characteristics approach to consumer demand and constitutes a proper

blend of carefully developed theory and interesting empirical observations. Using the linear programming format, he obtains the optimum budget for the consumer and examines the comparative statics of changes in tastes, quality, number of commodities, prices, and income. His analysis of the individual consumer is followed by interesting derivations of predictions about aggregate behavior under a variety of distributional assumptions and an examination of the form of diffusion curves for new commodities. Unfortunately, he has failed to state the mechanisms of information dispersion other than the epidemic effect. A discussion on advertising, quality change, and new commodities would have enriched his discussion.

Ironmonger's work is a stimulating combination of theory and empirical applications. Since it was completed early in 1961, one wonders why this "new commodity" has not been more widely discussed in the economics literature.

Psychological Theory

In traditional utility theory preferences are assumed to be given. It does not provide any explanation of what determines these preferences. Psychologists have made an attempt to diagnose the "real" cause of consumer behavior, i.e., to explain preferences. According to psychological theory a consumer purchases a commodity because he expects it to satisfy one or more of his basic "needs" or "drives." Some needs are biogenic (nutrition in food consumption) and others are psychogenic (taste and preferences). Biogenic needs arise when tension is created in the psychological system by the body entering a disequilibrium state -- e.g., hunger, thirst, sleep, and pain.

Psychogenic needs are precipitated by tension that develops as a result of an individual's association with other people. Psychogenic needs have been broadly classified into (a) the need for affiliation, (b) the need for achievement, and (c) the need for power.

These needs or drives impel a response but when, where, and how a subject responds is determined by "cues." For example, a cue inducing a consumer to purchase a commodity may be seeing an advertisement, seeing the commodity on display, or seeing someone else consume it. Thus, responses are determined by a combination of drive and cue. If the response is rewarded or reinforced, then the response will be repeated when the drive and cue coincide. According to Zaltman (1965), "Learning occurs when the repeated reinforcement of a response triggered by a cue causes a more or less permanent change in an individual's behavior" [See Thomas, 1972, p. 22]. A product or service that satisfies a biogenic or psychogenic need thus becomes a reinforcing agent or what is often called a "goal object." Whenever reinforcement takes place, the likelihood is increased that the person will seek the same goal object whenever he experiences the same drive.

The psychological theory of consumer behavior and the traditional utility theory are complementary in the sense that the former goes one step further back than the latter and attempts to explain preferences. However, consumer behavior is viewed from entirely different vantage points, with the psychological theory emphasizing the drive-cue-response-reinforcement process and dynamic formation of habits, while traditional utility theory stresses the importance of prices and incomes in a comparative static framework. Moreover, whereas the psychological theory is entirely "positive," the tradi-

tional utility theory has a "normative" element involving the debatable assumption of maximizing behavior [Thomas, 1972].

Neocardinal Consumer Theory

Praag's theory (1968) appears to be more realistic than the traditional theory. The first simplification of this theory is that the relevant commodity space, K_n (whose dimension n), is much smaller than that of the general commodity space Ω. The commodity vector $x = (x_1, x_2 \ldots x_n)' \varepsilon K \subset \Omega$, where x_i is the quantity of the i^{th} commodity, is no longer called a budget but a welfare position with respect to the relevant set K_n.

Given a relevant set K_n, neocardinal theory postulates the existence of a preordering (a comparability assumption) that more is preferred to less (a monotonicity assumption). In the usual way, the theory postulates the existence of an ordinal utility function U(x) on Ω, where U(x) is monotonically nondecreasing in all its agruments. So the total evaluation is given by $U(\infty)$. Further, U(x) is assumed to be normed to give $U(\infty) = 1$. Then the theory makes the assumption that it is possible to evaluate consumers' actual welfare position in a unique way by comparing it with the situation of total satisfaction given by $U(\infty)$. The implication of this assumption is the existence of a unique cardinal welfare function, U(x) on Ω. Since the welfare evaluation depends on the relevant set K_n at the moment under consideration, the cardinality implied in this theory is not the cardinality in the classical sense. For this reason, it is termed as neocardinality.

The welfare function U(x) defined on Ω, coincides with the

distribution function in statistics and often is referred to as welfare distribution. Its derivative, $u(x)$, is called welfare density function which in traditional terminology is the marginal utility function. It is interpreted as the welfare evaluation of the marginal x^{th} unit or rather, the x^{th} service derived from the x^{th} unit. Such services, which are identical with points of Ω, are called elementary services. These elementary services, although physically identical, are not interchangeable because they have been ordered and are differently evaluated according to their consumption order. A quantity of x units is actually a service set containing the first, second,...x^{th} services. This is evaluated by $U(x)$. That is, each unit's contribution to welfare is generally different. In other words, the welfare contribution of a unit depends on whether it is the first unit, the second unit, ... or the x^{th} unit consumed. The welfare function $U(x)$ does not evaluate a physical unit of the commodity but rather the service it renders. $U(x)$ is assumed to satisfy the following conditions: $\frac{\partial^2 U}{\partial x_i^2} < 0$, $i = 1, 2, \ldots n$,

$$\frac{\partial^k U}{\partial x_1 \partial x_2, \ldots, \partial x_k} \geq 0 \qquad 2 \leq k \leq n$$

Even if the consumer is aware of the relevant set K_n of n commodities, he frequently attempts to evaluate some, but not all, relevant aspects of his welfare position. This leads to the definition of a conditional welfare position which is measured by the appropriate conditional distributions of $U(x)$. The concept of statistical independence also implies the independence between commodities or groups

of commodities. The theory then makes the consistency assumption which states that the consumer evaluates his welfare position as if he were completely satisfied with respect to all commodities which are irrelevant at the moment under consideration. This assumption make it possible to consider total welfare with respect to a specific relevant set as a partial welfare evaluation with respect to a larger relevant set where the latter set includes the former. This leads to the definitions of partial welfare evaluations made possible with the marginal distributions of U(x). If K_1 and K_2 are the relevant sets of m and n commodities, respectively, then the two welfare functions U_1 and U_2 are said to be consistent if and only if there exists a welfare function U on $K_1 \cup K_2$ such that U_1 and U_2 are partial (marginal) welfare (distribution) functions of U with respect to $K_1 \cup K_2$, respectively, while the ceteris paribus conditions with respect to K_2-K_1 and K_1-K_2 are deemed irrelevant. In other words, in the language of mathematical statistics, both U_1 and U_2 have to be marginal distribution functions on K_1 and K_2, respectively, of a third distribution function U on K_1 and K_2. So this theory makes use of concepts of a probability density function, distribution function, conditional and marginal distribution of mathematical statistics. A few illustrations are given below.

(a) The switching from one relevant set to another is accomplished by using the concepts of marginal and conditional distributions in statistics. Let $X^{(1)} = (x_1\ x_2\ \ldots\ x_k)'$ and $X^{(2)} = (x_{k+1}\ x_{k+2} \ldots x_n)'$ be, relevant and nonrelevant sets, respectively, at a particular moment. $X^{(2)}$ is irrelevant because it is held constant -- the usual ceteris paribus conditions. Statements such as "given my

circumstances, I am completely satisfied with the house I have" or "since I have no car, gas is of no use to me" can be evaluated by conditional distributions. The welfare position of $X^{(1)}$ given $X^{(2)}$ is given by the conditional distribution of $X^{(1)}$ given $X^{(2)}$. That is, by

$$U(X)^{(1)}/\ X^{(2)}) = \frac{U\ (X^{(1)},\ X^{(2)})}{U\ (\infty,\ X^{(2)})} = \frac{U\ (X^{(1)},\ X^{(2)})}{U_2\ (X^{(2)})}$$

$$= \frac{\text{joint distribution of } X^{(1)} \text{ and } X^{(2)}}{\text{marginal distribution of } X^{(2)}}$$

In other words, the partial welfare evaluation of $X^{(1)}$ given $X^{(2)}$ is equal to the ratio of simultaneous welfare evaluation of both $X^{(1)}$ and $X^{(2)}$ to the partial welfare evaluation of $X^{(2)}$ alone. Marginal distributions are referred to as partial welfare evaluation by Praag. If $X^{(1)}$and $X^{(2)}$ are statistically independent, i.e., their joint distribution is equal to the product of their individual marginal distributions, $U\ (X^{(1)},\ X^{(2)}) = U_1\ (X_1) \cdot U\ (X_2)$, then the commodity sets $X^{(1)}$ and $X^{(2)}$ are defined to be independent. So in statistical language the assumption of irrelevance of $X^{(2)}$ is equivalent to replacing the joint distribution of $X^{(1)}$ and $X^{(2)}$ by the marginal distribution of $X^{(1)}$. This implicitly assumes that $X^{(2)} = \infty$ as $U(X^{(1)},\ X^{(2)}) = U(X^{(1)},\infty) = U_1(X^{(1)})$. This is referred to as the consistency assumption stated above.

(b) The relationship between, joint, marginal and conditional distributions are used to define interrelatedness among commodities. Since $U(X_1,X_2) = U_1(X_1)\ U(X_2\ /X_1) = U_2(X_2)\ U(X_1/X_2)$,

$$\log U(X_1,X_2) = V(X_1,X_2) = \log U_1(X_1) + \log U\ (X_2/X_1) = V(X_1) + V(X_2/X_1),$$

$$= \log U_2(X_2) + \log U(X_1/X_2) = V(X_2) + V(X_1/X_2),$$

where $V = \log U$.

Now, when X_1 and X_2 are statistically independent, $U(X_1,X_2) = U_1(X_1) \cdot U_2(X_2)$, which implies $V^*(X_1,X_2) = \log U(X_1,X_2) = \log U_1(X_1) + \log U_2(X_2) = V(X_1) + V(X_2)$.

Let the deviation function $C(X_1,X_2)$ from independence be defined as $C(X_1,X_2) = V(X_1,X_2) - V^*(X_1,X_2) = V(X_2/X_1) - V(X_2) = V(X_1/X_2) - V(X_1)$.

$C(X_1,X_2)$ is symmetric in X_1 and X_2.

The two commodities X_1 and X_2 are complements or independent or substitutes, accordingly, as $C(X_1, X_2) \gtreqless 0$, that is, accordingly as conditional welfare of X_1(or X_2) given X_2 (or X_1) is higher, equal to or less than unconditional welfare of X_1 (or X_2).

Now $\lim\limits_{X_1\to\infty} C(X_1,X_2) = \lim\limits_{X_1\to\infty} \{V(X_1/X_2) - V(X_1)\} = 0$,

which intuitively means that a given quantity of one commodity can be neither complementary nor a substitute for an infinitely large amount of any other commodity. In other words, any given quantity of one commodity can only be independent of an infinite amount of any other commodity. It may be noted that the above criterion of interrelatedness of commodities is conditional on a given quantity of one good. So it measures average complementarity or substitutability. It does not imply whether any specific unit of X_1 is complementary with or is a substitute for any specific unit of X_2.

Since $V(X_2/X_1) = C(X_1,X_2) + V(X_2)$ and $V(X_1/X_2) = C(X_1,X_2) + V(X_1)$, the two goods X_1 and X_2 are locally complementary or independent or substitutes accordingly as $\frac{\partial V(X_2/X_1)}{\partial X_1}$ or $\frac{\partial V(X_1/X_2)}{\partial X_2} \gtreqless 0$,

or, accordingly as $\frac{\partial C}{\partial X_1}$ or $\frac{\partial C}{\partial X_2} \gtreqless 0$.

This criterion is asymmetric as it should be.

At the margin the two goods X_1 and X_2 are complementary, independent or substitutes, according as $\frac{\partial^2 C}{\partial X_1 \partial X_2}$ or $\frac{\partial V(X_1, X_2)}{\partial X_1 \ \partial X_2} \gtrless 0$. Again this criterion is symmetric. These criteria can be easily extended to two or more groups of commodities. It may be noted that these criteria and Edgeworth's criterion (based on the sign of $U_{ij} = \frac{\partial^2 U}{\partial X_i \partial X_j}$) do not depend on the price situation, as do the Slutsky criterion and gross substitutability criterion. That is, Slutsky and gross substitutability and complementarity are meaningful only in a monetized economy. This seems unreasonable because the interrelatedness between commodities should depend on the intrinsic qualities of the commodities and hence not on whether the economy is on a monetary or nonmonetary system. It seems reasonable to base interrelatedness on both intrinsic qualities of commodities and behavioral patterns of consumers. Thus, in Chapter V of the present study, two types of interrelatedness among foods are defined -- one based on nutritive quality of foods (nutritionally substitutes, complements or independent) and the other on the Slutsky substitution terms which describe economic behavioral patterns. The final criterion of interrelatedness is based on the sign of the sum of the two terms given above.

This neocardinal theory of consumer behavior is a stochastic approach because the utility function (welfare function) is the distribution function of mathematical statistics and as such yields meaningful interpretations of variances and covariances of commodities. The commodities with a large variance are commodities for which satisfaction comes rather slowly. Much welfare mass is found in the tails in popular statistical terminology. Commodities with small variance

are those with which the consumer is quickly satisfied by only a small quantity. For instance, commodities that are life necessities should have less variances. Covariances provide another criterion for classifying the commodities as complements, independent or substitutes. $\mathrm{cov}(X_i X_j) \gtreqless 0$ implies that goods i and j are complements, independent, or substitutes. This idea may be useful in analyzing intercorrelations among nutrients. If the consumption vector q has mean μ_q and variance-covariance matrix Σ_{qq}, then the nutrient vector $Z = Bq$, where B is the consumption technology matrix, has mean vector $\mu_z = B\mu_q$ and variance-covariance matrix $\Sigma_{zz} = B\Sigma_{qq}B'$. Various multivariate methods can then be applied. With the added assumption that q follows a multivariate normal distribution, Z would have a multivariate normal distribution.

Finally, this neocardinal theory also incorporates elements of uncertainty and dynamic aspects of consumer behavior. The path of consumer theory has been from cardinality to ordinality and from ordinality to neocardinality.

Relevance of Consumer Behavior Theories to the Demand for Food

Although demand analysis is one of the oldest areas studied by economists, there are still many unresolved issues. Fundamental difficulties remain in applying the theory to real world problems. A variety of decisions with respect to choices among alternatives underlie consumer behavior. Even when the problem is limited to its economic aspects, several distinct and separate phenomena may be singled out for detailed analysis. A survey of research on consumer behavior reveals a wide variety of possible approaches to the subject. The following discussion of fragmentation of one elegant, intellectual-

ly appealing, and aesthetically beautiful theory in international trade gives some insight. The best-known statement of the tenets of traditional trade theory is the Heckscher-Ohlin theorem. The basic theory is intellectually pleasing. But the Leontief paradox caused trade theory to be developed along two lines.

(a) In the first line an attempt was made to keep a single elegant model to explain trade patterns and their effect on world and national economies.

(b) The claim in the second line was that a single elegant model could not explain the diverse patterns of trade in the world. Thus the theory became fragmented, losing its universality and usefulness in explaining macrophenomenon. However, it gained in its ability to explain the observed patterns of international trade. This group moved away from the idea of a single elegant model to explain the observed patterns in many types of goods in international trade and simultaneously to perform the services of the Heckscher-Ohlin model in explaining effects of changes in trade on national and world economies. In sacrificing the comprehensiveness and intellectual appeal of a single, elegant, mathematical or geometric model of Hechscher-Ohlin, these economists did gain accuracy in explaining observed patterns of trade for different types of goods.

These economists broke away from the restrictive, but very explicit assumptions of the Heckscher-Ohlin model. They were willing to make different assumptions for different types of goods and introduce dynamic elements. The majority were willing to keep something close to Heckscher-Ohlin model for agricultural and natural resource-oriented products. But for manufacturers' products, the

approaches were numerous and included, for examples, Kravis' availability theory, Posner's technological gap theory, Linder's theory for manufacturers, and Verner's product cycle theory [Posner, 1961; Kravis, 1956; Linder, 1961; and Vernon, 1966]. One can see the same phenomenon occurring in consumer demand theory. The above review shows that the theory is being fragmented along two main lines -- one for durables and the other for nondurables. To allow for the specific nature of individual commodities, further fragmentation of the theory is inevitable. For example, the nutrition component of the demand for food items has not been explicitly analyzed. The present study attempts to improve the explanation of food purchase behavior by accounting for the nutrition component of the demand for foods with appropriate assumptions. The demand for each food item is analyzed in terms of two components -- nutrition and nonnutrition. The traditional and the new approaches are both used.

Before discussing the approach proposed for the present study the limitations of applying the traditional and technological and other theories are considered. The position of traditional and new theories can be seen in Figure 1. Given a food budget constraint, $p'q = m_f$ (m_f = food expenditure), both theories begin at the goods vertex C and end up at the satisfaction vertex A via different paths (routes). The traditional theory's route to A is direct via $u(q)$. The new theory's route to A involves two steps. The first is from goods vertex C to the objective characteristics vertex B via the consumption technology $z = Bq$; the second is from the characteristics vertex B to the satisfaction vertex A via $u(z)$. If one traces back the paths, it is clear that in traditional theory the demand for goods is direct; the

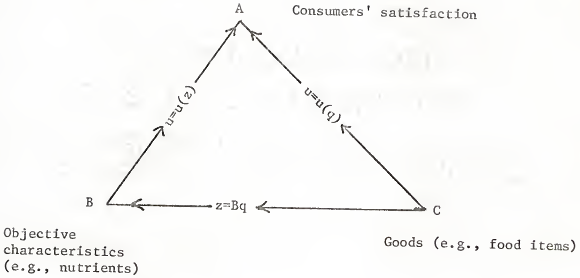

Figure 1. Relation of new theory to traditional theory

objective characteristics (z) do not appear in traditional theory. In the new theory the demand for goods is indirect. In addition, there is no place for subjective characteristics in the new theory and no place for objective characteristics in the traditional theory. In other words, traditional theory could handle the nonnutritional factors but not the nutritional factors, whereas the new theory could handle nutritional factors but not the nonnutritional factors. If equilibrium in the new theory occurs at $z = z°$, the consumer attains a satisfaction level $u(z°) = u°$. The choice of a commodity bundle that gives rise to this $z = z°$ is a pure efficiency choice; no preference for goods, which is highly unrealistic for food products, is included in the new theory. The consumer is a living animal and is not an inanimate thing such as an engine of an automobile where brand of gasoline used is immaterial other than for efficient operation.

The importance of nonnutritional factors in food consumption has long been stressed by many research workers studying food consumption patterns. Many economists are carried away by the beauty of abstract quantitative models and they ignore the contribution of sociologists and anthropologists to economic analysis and hence lose touch with the reality and complexity of actual food consumption decisions. Peoples' values, attitudes, and cultural practices may often be more important determinants of food consumption than are income, urbanization or availability of foods. These aspects must receive their due consideration even though information about them is mostly qualitative. Most often it is the ignorance of nutrition and the cultural inflexibility of food habits that make people in developing countries reluctant to change their dietary practices. The paradox

that many high income countries with food surpluses have pockets of malnutrition is primarily due to the low income of some people and not the low income of the economy (the cure being some kind of income redistribution), and secondly to poor food habits, i.e., the nonnutritional factors (the cure being some kind of expenditure switching). Although higher income facilitates increased food purchases, the resulting diet changes may not be nutritionally desirable since the nonnutritional factors are likely to dominate the nutritional ones.

Evidence suggests that both the rich and the poor buy nutritionally poor foods. To quote from Madden and Yoder (1972, p. 14), "Families achieve a greater nutritional efficiency (more nutritional value per dollar of food cost) when less resources are available.... The nutritional efficiency with which the additional food dollars are spent tends to decline as the family's diets improve. The poor families who feel deprived in other ways may choose to compensate by buying such foods many of which may be very low in nutritional value." Hence, there are some invisible costs that are "real" in the sense that aesthetic or psychic satisfactions obtained from a particular food choice constitute a few of the very limited pleasures available to the poor consumer. That is why the linear programing least-cost diet which enables the consumer to achieve a specified nutritional level with a minimum cost, given prices of the foods, has never been realistic for human beings because it ignores the fact that the consumer buys "other things" (nonnutritional factors) besides nutrition when he buys food. So Lancaster's theory is more suited to consumer durables where characteristics receive more attention than the goods themselves. It is also true that the subjective (nonnutritional) characteristics of

goods are ignored when one works in the space of objective (nutritional) characteristics as in new theory with u = u(z). It is a highly serious limitation as far as food items are concerned. Moreover, objective (nutritional) characteristics are completely neglected when one works in the goods space as in traditional theory.

Therefore, a model is needed which integrates objective (nutritional) and subjective (nonnutritional) characteristics. Analysis based on such a model should reveal the structure of these two underlying factors. The situation is no better in Ironmonger's theory which, with all the limitations of Lancaster's approach, further assumes the prior ordering of wants (nutrients in the present case). In view of the fact that nutrition is subsumed in food behavior, it would be unrealistic to assume prior ordering of nutrients. Moreover, since nutrient allowances are not generally met, the marginal want (or nutrient) will more likely be first or second in this hierarchy.

Psychological theory was compared earlier with traditional theory. The underlying ideas of biogenic and psychogenic needs of the theory are useful to distinguish between nutritional and nonnutritional needs in the use model developed in the present study. The psychological process involved in this theory is difficult to quantify. The best one can do is to use the household characteristics that, hopefully, may reflect psychological needs.

A close review of consumer demand analysis reveals that it has developed along two separate but related lines: (a) discovery of general market laws -- particularly agricultural market laws developed by agricultural economists, and (b) discovery of psychological laws -- the theory of consumer preferences developed by statisticians and

quantitative economists. The latter development is more relevant to the theoretical aspects of general equilibrium analysis and welfare economics. The former development is more relevant to applied demand analysis, which is the main concern of the present study. Praag (1968) claims that his book is primarily for use by theoretical economists, secondarily for psychologists and market analysts, for investigation of nonhomogeneous commodity groups and for use by probability theorists and mathematical statisticians because of the fact that the model employed coincides with that used in probability and statistics. So his theory is more theoretically oriented and less applicable to empirical demand analysis. It may have a more fruitful role to play in general equilibrium and welfare economics.

CHAPTER III

NUTRITIONAL CONSIDERATIONS

The adverse effects of inadequate nutrition on both physical growth and mental development are discussed in this chapter. Though the discussion is centered around the importance of the adequacy of the nutritional component, $q^{(1)}$, the importance of the nonnutritional component, $q^{(2)}$, is not ignored because both components interact in influencing the total health (or personality) of human beings. Man's physical or biological conditions are both related to his emotional, psychological or mental conditions. Pyke (1968, p. 1) implied this relationship when he wrote, "Health is a subtle intermingling of psyche and soma." The nutritional component has a direct effect on physical health and an indirect effect on mental health. The non-nutritional component, a subcomponent of environmental stimulation, affects emotional status directly and physical health indirectly.

Many laboratory experiments with animals have shown conclusively that the conditions of two sets of variables, applied early in life, have a permanent effect on development of any organism. The first set of variables, the quantity and quality of food administered in early infancy, has primary role in body building. That is, the first set of variables relates to the nutritional component, $q^{(1)}$, of food consumed. The second set of variables, quantity and quality of

environmental stimulation, consists of a vast complex of external factors which affect the development of the central nervous system and the central nervous system is the primary determinant of emotional status. The nonnutritional factors underlying food consumption belong to the second set of variables. Laboratory studies on animals support the fact that the optimal development of an animal results from an appropriate combination of the two stimuli -- nutritional and environmental or physical and mental elements. Early deprivation of food was shown to lead to changes in behavior and learning which persisted into adulthood. A reduced caloric intake by rats in their early stages of development was shown to have led to a reduced spontaneous activity in adulthood. A decreased food availability was found to be associated with reduced exploratory behavior of laboratory animals. These effects were found to be modified appreciably by psychological stimulation such as personal handling or manipulation of these infant animals. Such environmental stimulation was shown to promote the development of the central nervous system, to increase the intensity of spontaneous activity in adulthood and to alter their reactive capacity to psychotropic drugs. In orphanages nutrition of children is normally adequate as they receive a well-balanced diet. Yet these children exhibit the manifestations of developmental retardation frequently because of lack of environmental stimulation. It is also interesting to note that the handled animals in such studies lived longer and grew somewhat faster than the unhandled ones [Schrimshaw and Gordon, 1968].

Until recently, the structural organization of the brain was believed to be determined exclusively by morphogenetic variables.

However, recent studies have provided experimental support to the idea that the morphology of the brain could be affected or modified by behavioral or social variables. The underlying reason for this possibility of modification of morphology of the brain by social variables is the research finding that a considerable proportion of cell population of suprasegmental brain structures in mammals is of postnatal origin. That is, postnatal changes in brain structure are conceived to be possible by this finding. Severe malnutrition during the first two years of life, when brain growth is most active, causes a permanent reduction of brain size and results in a restricted intellectual development. Effects of malnutrition on learning and behavior were shown to come from some specific action of nutrient deficiencies on the morphology and biochemistry of the individual cells of the brain and other parts of the central nervous system.

Malnutrition affects two growth processes of a living organism. The first process is characterized by cell division (hyperplasia) and the second is characterized by cell enlargement (hypertrophy). Though the process of cell division precedes that of cell enlargement for any organ, there is an intermediate stage when both processes may be occuring. That is, the growth process of any organ is characterized by three phases: (a) cell division, (b) cell division and cell enlargement, and (c) cell enlargement. The transition from one phase to the next is achieved by a slowing and cessation of DNA synthesis [Winick, 1968]. The timing of these phases is in general different for different organs and for different animals. Malnutrition is shown to interfere with both processes. Nutritionists argue that the recovery from adverse effects of malnutrition is possible with nutritional re-

habilitation only if the malnutrition has occurred after the first phase. That is, adverse effects of malnutrition are irreversible if it occurs during the earliest phase of cell division. So the most vulnerable group includes the fetus, the infant, pregnant and lactating women, and to some extent preschool children. This period of physiological vulnerability is further complicated by inevitable dependence of children for their food on their parents and other adult members of the family who decide their diet within their own respective cultural norms. In other words, young children are very much at the mercy of their environment.

Arguments on the possible adverse effects of malnutrition have been based on studies of laboratory animals. There are two difficulties in extrapolating the results from experimental animals to human beings. The first difficulty is that the timing of brain development generally differs between animals and humans. The second difficulty is that humans develop in a highly complex psychosociocultural environment. Hence human malnutrition cannot be isolated from the nonnutritional factors that are caused by and contribute to malnutrition. Thus, nonnutritional elements can affect physical growth and mental development. For nonhuman animals, once the definition of malnutrition, its type and duration, and the animal's age at the time of incidence are known, adequate controls can be imposed and the problem can be solved in a relatively short time. This cannot be done in the case of human beings for both practical and ethical reasons.

Since stress situations are negative environmental stimulation, adverse effects of stresses -- physical or physiological and psychological or emotional -- need to be considered. The physical

stresses can directly affect the physical constitution and indirectly affect emotional constitution. The psychological stresses can directly affect emotional status and indirectly affect physical condition. The physical stresses act through biological processes and produce nutritional imbalance. It is difficult to understand the nutritional implications of emotional stresses as they indirectly come from changes in the central nervous system. Unfortunately, these nutritional implications of emotional stresses go unnoticed.

With this brief introduction to the roles and mechanism of the operation of nutritional and environmental stimulation on man's total health status, the implications of inadequate nutrition or malnutrition on human learning and behavior are considered next.

Effects of Malnutrition on Learning and Behavior

Food is associated with quality of human health and behavior to a much greater extent than is the case with most other commodities. Therefore, knowledge of the possible adverse effects of malnutrition and constant hunger on human welfare is of the utmost importance. Hunger and malnutrition affect human behavior directly by reducing vigor, ability to cope with stresses, and interests in pursuits other than those of securing food. In a Minnesota study of experimental starvation [Keys, Brozek, Henschel, Mickelsen,and Taylor, 1950] in which well-nourished young men participated, the results revealed startling effects of starvation and hunger. During the semistarvation period of six months, these volunteers lost 24 percent of their weight on an average. Beyond six months, the subjects acquired an all-absorbing concern with food and eating. They talked and dreamed only

about food. Everything that concerned food became extremely interesting. They also showed dramatic changes in nonfood behavior. Sociability, grooming, ability to plan and participate in group activities and interest in sex dropped off significantly. The subjects rated themselves as lacking in self-discipline and self-control. They became restless, indecisive, sensitive to noise, and unable to concentrate and cope with even ordinary stresses of everyday life.

Nutritional rehabilitation reversed these trends. It was observed that behavioral patterns were relatively slow in this reversal process. Near the end of the three-months' rehabilitation period, morale, vigor, humor, enthusiasm and sociability gradually returned and irritability declined. Sexual interests were very slow in recovery. This was an experimental study in which the subjects had no previous history of undernutrition and malnutrition. The behavioral consequences are more permanent, severe and varied when hunger and starvation are the common conditions in early life. Chronic hunger and malnutrition, associated with extreme poverty, cause behavioral patterns characterized by hopelessness, apathy, listlessness, and lack of initiative. Where malnutrition is a common condition, a large percentage of the population will never be able to achieve its full potential as human beings or as economic agents. Severe food restriction in early life has been shown to produce high levels of excitability or excessive emotional behavior when subjected to stressful situations. The intense frustrations of constant hunger and severe mulnutrition are reflected in the following characteristics, habits, and customs of the society: (a) hasty preparation of food in simple forms, (b) remarkable absence of dining etiquette, ritual and

routine and reluctance to share food, (c) overeating whenever possible, (d) frequent quarreling about food is noticeable and insults are expressed in terms of food, (e) aggressive and uncooperative behavior, (f) cohesive units larger than family are absent, (g) sex and marriage behavior patterns are rooted in food provision -- food provision and economic security are the only means to secure marital partners and food provision is the only means of securing extramarital partners; preference for fat women over thin or slim women is noticeable, and men who are good hunters or food providers and women who are good in food gathering are in high demand, (h) the lack of a positive approach to economic activity other than procuring food, (i) low resistence to disease and diminished learning potential, (j) lack of environmental stimulation, (k) political unrest and family instability, (l) a lack of social and political leaders, (m) large families, (n) physical stature of people is relatively small, and (o) number of school drop-outs is very high [Gifft, Washbon, and Harrison, 1972].

Malnutrition in infancy and childhood has lasting adverse effects on physical growth and mental development. In particular, protein-calorie malnutrition in infancy causes mental retardation. It interferes with learning during critical periods of development. Malnutrition results in a reduction of a child's responsiveness to stimulation and in the emergence of various degrees of apathy. This apathetic behavior of a malnourished child will result in reduced responsiveness after reaching adulthood. Thus apathy can provoke apathy and hence can contribute to a cummulative pattern of reduced child-adult interaction. The child-adult interaction is very essential for environmental stimulation, learning, maturation, and, above

all, for interpersonal relations and social adjustment. Malnourished children exhibit impaired learning and retarded behavior. So it is unreasonable to expect a malnourished child to be attentive in classrooms and to be motivated to learn. Such children exhibit the characteristics of psychologically defective functioning, school failure, and subsequent subnormal or suboptimal adaptive functioning. For these children to continue in school means facing a series of frustrations and failures which create a negative self-image. Dropping out from school may be good for them as it enables them to sustain their positive self-image and leaving school is usually interpreted as a sacrifice almost indispensable for economic survival of their families. A low level of adaptive functioning, lack of modern knowledge, social custom, infection and insufficiency of food stuffs and environmental stimulation produce malnutrition that results in a large pool of survivors who will function in a suboptimal way. This pool of survivors, in turn, will choose mates of similar characteristics and rear children under similar or even worse conditions and produce a new generation of more severely malnourished individuals [Berg, Scrimshaw, and Call, 1971]. High positive correlation exists between malnutrition and subhuman or suboptimal functioning of the mind and body. Psychologists conclude from psychological experiments that success generally leads to a raising and failure to a lowering of the level of aspirations. Changes in aspiration are in part a function of changes in the subject's confidence in his ability to attain his goals. Thus the decreased physical efficiency and effectiveness resulting from nutrient deficiencies may in turn lower the level of aspiration of the people affected and tend to perpetuate the

conditions that cause them. Malnutrition may affect intelligence to the extent that the intellectual capacity of a highly gifted individual would be lowered to normal levels and that of a normal person to the level of an idiot [Belli, 1971].

The concern about whether or not the adverse effects of malnutrition are irreversible has dominated nutritionists' thinking much more than has public policy considerations to avert malnutrition. This is unfortunate because public policy considerations are more important than reversibility or irreversibility of effects of malnutrition in view of the fact that reversibility is germane only when the malnourished have a chance to achieve better nutrition in their life time. This opportunity has not existed for a vast majority of peoples of underdeveloped countries. It is also unfortunate that a lack of understanding of the basic fact that human behavior is largely the result of conditions of life causes the better nourished people to complain about irresponsible foolish or lazy behavior of malnourished people. The implications of such adverse effects on learning behavior and productivity of a malnourished society with respect to opportunities for social and economic development are self-evident.

Political and Economic Implications of Malnutrition

Only well-nourished, healthy people will have the will, self-confidence, and hope to build a better future for themselves and their children. The food situation affects peoples' health, their productivity, and their social and political attitudes and behavior. In countries with a democratic government, very few people are likely to question the right of freedom of speech and freedom of thought. On

the contrary, these are the very basic preconditions or prerequisites of a democracy. Since the intellectual capacity of undernourished and malnourished people is diminished, their freedom of thought, which is a precondition for the freedom of speech, is abridged. This has a political implication that a democracy may not survive or at least may not work properly in an undernourished and malnourished country. Whenever there are malnutrition problems there are also population problems. Some persons argue that malnutrition is a cause of over population. The reason put forward is that malnutrition causes a high infant mortality rate which is believed to be a major reason for having many children. It is argued that adequate nutrition would reduce the fertility rate. So underlying the population problem is the problem of nutrition. The countries with widespread malnutrition are bound to have population problems and often associated social, economic, and political problems. These countries are easy prey to communism or dictatorship. Some people attribute food shortages in communist countries to their political philosophy. Some even go to the extent of saying that communist countries can never produce enough food [Farber, Wilson, and Wilson, 1966]. Their main point is that the underlying political philosophy of communism is a barrier to "abundance." There appears to be a confusion between cause and consequence here. Once the people are well nourished in communist countries, their mental development and indellectual capacity increase and they begin to assert their individual rights one by one. So it may be very difficult for communism to survive in well-nourished societies. Whatever the political structure may be, successful solution to food and nutrition problems are an important buttress to economic development; failure can bring develop-

ment to a halt. The uniform tenor of the growing body of research on the consequences of nutrition deficiencies supports the thesis that its prevalence among substantial numbers of people in less developed countries reduces their current physical productivity and impairs their psychological capacity for improving their condition. In both respects these nutritional deficiencies act as a brake upon the agricultural and industrial development of the nation.

The biological or physiological deprivation is not necessarily the same as economic, social or cultural deprivation because biological needs are basic. One can say that the adequate meeting of these basic nutritional needs merely sets a stage for the more direct improvements in learning and behavior which are basic to economic, social and cultural progress. For the less developed countries, the hypothesis is advanced that the most probable short-term bottleneck in the process of human capital formation is a deficit in preschool types of investment in human capital, infant nutrition being one of them. These early deficits in human capital formation can rarely be made up by later investments. While quality of education and job training are the important determinants of superior human capital, adequate nutrition is a primary determinant of the ability of individuals to benefit from such education and training. That is, adequate nutrition is basic to a high quality labor force. Labor productivity is believed to be directly proportional to nutrient intake. Malnutrition should not be viewed as something static; it is a dynamic process of malnourishing just as so-called underdevelopment to a great extent is a dynamic process of underdeveloping. The vicious circle of poverty is reinforced as malnutrition and hunger are intensified because of negative

effects of suboptimal human functioning on economic and social development and the subsequent effects on food availability and its quality. If the circle is not broken, the gap between the "haves" and the "havenots" in society will eventually widen.

Food is not the only need that is ill-supplied in conditions of poverty, but it is one of the most basic needs and as such it offers a logical point of intervention for breaking the circle. Inequalities of income within and between countries can be explained to a great extent by histories of malnutrition in the countries. Hence the investigation of the role of nutrition in national development of countries is interesting and relevant investigation of relationships among nutrition, health, education, population growth, political and military power, agricultural and industrial development, and intellectual achievements of a nation is important and badly needed. A number of economists put forward an hypothesis that in these low-income countries, there is a negative nutrition multiplier effect -- inadequate nutrition implies lower labor productivity which causes increased under- and unemployment. This in turn implies reduced labor earnings which result in reduced effective demand in the economy. This process further worsens the nutritional status of labor. The multiplier effect of investment in food, nutrition, and health could be highly significant [Berg,Scrimshaw, and Call, 1971].

Development of human resources through nutrition, health, and education has been considered as a welfare or even a charity problem and budgeted accordingly in many countries. It is only recently that the view that expenditure on these matters can be an investment with high rates of long-run returns has gained support. The recent research

findings on malnutrition, particularly protein malnutrition and its adverse effects on mental development, learning and behavior, have shaken the foundations of educational efforts which presume that all children in the country are endowed with requisite intellectual capabilities to absorb knowledge and to learn. Because of inadequate brain development, apathy and disrupted behavior patterns caused by widespread malnutrition in poor countries, the returns on educational investments have been unsatisfactory. Educational and social returns probably would have been much more impressive if part of the educational funds were allocated to alleviate or eliminate protein malnutrition within the most vulnerable groups -- pregnant and lactating women, infants and preschool children -- and the remaining part to regular education. The suggestion that additional health facilities will motivate economically backward people to achieve higher output in small-scale activities like agriculture and home industry has been supported by studies made in India, Nepal, and Appalachian regions of the United States [Malenbaum, 1970]. It is believed that nutritional improvement would result in similar motivation.

There are many difficulties associated with incorporating nutritional programs in national development efforts. Lack of nationwide awareness of nutrition, excessive reliance on aggregative data which blur the view of microaspects of nutrition and the technical nature of the present state of nutrition, which has resulted in a wide communication gap between nutritionists and economic planners, are a few of the difficulties. The most important difficulty has been the vagueness of interrelationships between nutrition and other aspects of national development. It is one thing to make hypothetical statements

such as: (a) protein-calorie malnutrition is the central cause of underdevelopment of poor nations, and (b) there exists a strong synergism between the debilitating effects of malnutrition and environmental deprivation on physical growth and mental development of children, etc. But, it is quite another thing to convert or translate these hypotheses into hard propositions by defining precisely the concepts involved, quantifying and identifying them with observations and estimating the coefficients of the relationships. So far, in their effort toward national development, a number of countries have identified broad and generalized goals and adopted ad hoc policies to achieve them. Other countries have clearly defined goals and have formulated plans and consciously selected action programs from among the available alternatives. Most countries will be somewhere between these extreme cases. Nutrition may or may not be an objective or may not even be a resultant by-product of any of their programs. The costs of malnutrition -- educational loss, the loss involved in high child mortality rates, fertility rate and population growth, reduced productivity of the labor force, and above all the loss of biological and psychological well-being -- are too important to be ignored [Berg, Scrimshaw, and Call, 1971].

Nutritional Implications of Economic Development

The above discussion of the economic implications of nutritional improvement leads one to a discussion of nutritional implications of economic betterment of the people. The topic "food and nutrition" has a wide range of aspects covering nearly almost every academic discipline from the natural and biological sciences to medi-

cine, the humanities, and the social sciences, as well as religion. But the interest of economicsts has been confined mainly to "food in the market place." In order of importance food and shelter have been the two basic human needs regardless of a country's stage of economic development, industrialization or affluence. These two items correspond to the survival and security needs, the first two in Maslow's (1943) hierarchy of human needs discussed in Chapter I. The top priority of food will never change even though other social, cultural, and economic aspects of food may undergo extraordinary and continual changes as society marches forward on its social and economic fronts. Because of this unique place and universal nature of food, some people consider the analysis of food consumption patterns to be a simple method of determining what stage of social and economic progress the country has achieved. There appears to be a clear evolution in food consumption patterns in the main evolution of social and economic transformation. The stage in which the food ways of the underdeveloped areas of Asia, Africa, and Latin America are at present has already been passed through by the affluent areas of western Europe and the United States.

In order to understand this evolution of food ways within the main evolution of affluence, it is convenient to classify nutrients into two broad categories: (a) calorie energy-bearing component, and (b) protective or body-building and cell-building component. The main source of the former component is carbohydrates such as starches, sugar, alcohol, and fats and oils of vegetable and animal origin. The latter component consists of protein, minerals and vitamins. The general preference pattern of people with low incomes appears to be

that first calorie requirements are satisfied and second the minimum protein, mineral and vitamin requirements are fulfilled. Animal proteins are relatively less abundant, more costly, and superior in quality as compared to vegetable or plant proteins. In general, the income constraint compels people to consume cheap sources of nutrients. As income increases, they consume more costly and superior quality nutrient sources. Analogous to Engel's law, there is Bennett's law [Bennett and Pierce, 1961; and Bennett, 1954] which states that in the diet of a country or a community the proportion of calories derived from starchy foods such as cereals, potatoes or tapioca, tends to decline as the average per capita income of the country or community increases. Thus, depending upon the stage or degree of economic development of a country, calorie intake from such starchy foods as bread, cereals, potatoes, manioc and plantains, ranged from 30 percent to 80 percent. As per capita income increases with economic development these calorie requirements are met by consumption of more sugar, fatty meats, eggs, and vegetable fats, such as butter, margarine, mayonnaise, cooking oils. A similar pattern of protein intake appears. As the per capita income increases, more animal protein is consumed in place of plant protein because animal products are more palatable and satisfy the desire for variety in diets. Thus, as the income of a society increases, there is a tendency to replace the most inexpensive source of vegetable proteins (cracked cereals, whole wheat bread, unpolished rice, peas, beans and lentils) with more expensive animal proteins (fish, clams, muscles, lobsters, squid, caviar and other sea foods, milk, cheese and meat). Within the animal products there are again preferences for higher quality tender meats, such as that from

younger animals and from grain-fed animals. There is a tendency towards easily digestible proteins from milk and milk products [Farber, Wilson, and Wilson, 1966].

Increasing economic development lowers the calorie need. Use of mechanical power, better home heating, automobiles and elevators lowers the need for calories. Thus, people switch to low-calorie high-vitamin foods such as fruits and vegetables.

Once people are accustomed to seasonal foods, their increasing income induces them to pay a high premium to have seasonal foods throughout the year. The need to develop food preservation and to improve food safety follows economic development. The increasing affluence has encouraged continual search for better methods of food processing and preservation which has yielded revolutionary results. One can see that the ancient methods of salting, sugar curing, pickling in brine or vinegar, cool storing in sand, dehydrating and smoking are still prevalent in poor countries, while the developed countries have much improved and modernized these methods -- canning, sterilizing by heat, chemicals, waves, and high voltage currents, refrigeration, freezing, quick freezing, vacuum dehydration of liquid foods and lastly, freeze-drying with liquid nitrogen at extremely low temperatures. Freeze-dried foods have high export potential as they are very light, can be highly compressed, and require only inexpensive dry storage. The dominant incentive in all these developments of food technology has been the consumers' sophisticated preference pattern in response to improved economic conditions.

Another very remarkable change is the increased tendency towards packaged processed convenience foods with built-in kitchen

and/or maid service as the consumer's income rises. As a consequence of these developments, the American diet is the most advanced in the world -- it combines the most attractive features of nearly all other national diets with maximum sanitary safety and a high level of guarantee for public health.

Food is an important raw material for the industrial economy and food costs are an important factor in calculations that are used to guide economic policies in many countries. In the process of economic development, the improved methods of agriculture have tremendously increased the agricultural output in general and of food crops in particular. Food technology continues to make steady progress. Scientists are working to discover the interrelationships that exist between food and the complicated systems of body and mind. Changes continue to occur at a rapid rate in response to general economic improvement.

The above discussion of nutritional consequences of economic development no doubt reveals the improved nutritional status that accompanies ingestion of high quality nutrients. But the economic efficiency with which given levels of nutrition are achieved appears to be decreasing. The old idea that food must come from the earth, air, rain, plants and living things is losing ground because of the advent of substitute chemical formulae taken in compressed and varied forms. The inborn sense of taste of people, the most pleasurable aspect of food eating, is on the wane because the kitchen, in part, has been replaced by laboratories and other parts of the food industry. There is a lesson in the progress made in working out suitable diets for astronauts. Astronauts are being treated, shaped, and trained to

swallow capsules of vital food made to taste like carrots and peas, and perhaps eventually trained to cope with physical, emotional and moral stresses of which earthbound people have never dreamed. It is really interesting and even fearsome to speculate on the possible changes that might occur in three basic hungers -- hunger for food (survival need), hunger for shelter (security need), and hunger for love (need for belonging). Expanding population and dwindling world resources may force scientists to look for an altogether new type of technology that could transform human living conditions. Man may have to give up his most conditioned habits -- habits of eating three meals a day, sleeping when it is dark, etc.

Already most aspects of American daily life have been mechanized. Women have been relieved of much of the drudgery of housework and food preparation and are able to take jobs outside the home. Eating away from home has been increasing. So, there has been an increase in the demand for convenience foods. Almost all foods have lost their regional character because of efficient transportation and storage systems. They have also lost their seasonal character because of modern methods of canning, freezing and freeze-drying. Food habits are tending towards uniformity because every food is available all over the country and is widely advertised. Lastly, the vastly improved communication system, through its print-media and audio-visual media, is exerting tremendous influence on food buying patterns. The advertisements in the media have both good and bad aspects. In general, because a large number of consumers are exposed to the same influence of advertising, it tends to reduce the differences in eating patterns of people. Food advertisements make available a large

amount of information on food recipes, suggestions for food preparations, ideas for parties, food safety, food budgets, nutrition and diet, health hazards of overweight, food additives, kinds and amounts of fat in the diet, weight control methods, etc. They broaden food acceptance. Educational TV stations discuss food and its relationship to health and well-being.

One conspicuous and adverse influence of mass media is that advertising induces people to buy things other than food. This approach makes people thing-oriented and hence people may be more responsive to nonnutritional than nutritional aspects of food and diet. The influence of mass media has been so great that one can say it is the mass media that constitute the mass market and not the people. Thus radio and television, rather than grocery stores, are the market place for many items. Grocery stores have become the distribution centers. Marketing analysts are emphasizing the need of what they call "Communigraphic" information -- the communication profile of the area and its people in addition to their traditional demographic and psychographic data. This structural change is a consequence of affluence [Berg, Scrimshaw, and Call, 1971].

Present Status of Nutrition in Relation to Economic Development

If one reviews critically the current literature on the national development process, one can observe three shifts of emphasis in development thought: (a) shift from food as a goal to food as a means, (b) shift from quantity to quality, and (c) shift from purely economic to humanitarian approaches. Early development thought emphasized increases in quantity and purely economic considerations,

whereas more recent development thought has been emphasizing quality and humanitarian considerations together with quantity and economic considerations. A shift from food as a goal to food as a means implies that certain issues such as nutrition, health or human resource development are considered as ends or goals of the development effort. These are believed to be automatic accompaniments of development [Berg, Scrimshaw, and Call, 1971]. The various components of human well-being were viewed in a very broad economic content in the early ideas. In this context, malnutrition was viewed as a consequence of underdevelopment and poverty and hence general or overall economic growth would eliminate poverty and in turn malnutrition. This line of thought is marked by the view that all components of human well-being, including nutrition, are goals that would be reached by means of general economic progress. This view is beset with many pitfalls. First, nutrition, health, and education are causes as well as consequences of economic conditions. In general human resource development is not merely a goal or consequence of economic development but is also a means to economic progress. Hence the view that nutritional and health expenditures are investment expenditures, and not merely consumption drains on the economy, is widely accepted in modern thought.

Secondly, general economic growth does not necessarily imply increased well-being for every consumer in general or for those who are in real need in particular. Distributional and welfare consequences of growth must be considered. Lastly, improvement in family income may mean a higher food expenditure but may not result in the purchase of a quality diet. This is a matter of food ways which are

culture-bound. Actually, economic growth has not been noticeable in many countries because of accelerated population growth. So, the shift of emphasis to nutrition and health care as investment rather than humanitarian goals is very significant in modern development thought. Many examples may be quoted to contradict the presumed automatic relationship between general economic improvement and nutritional improvement. The peasant farmer who lives on a worsening diet while raising cash crops is one example. The transitional culture of urban shanty towns with bottle feeding as a substitute for breast feeding is another. Ironically, malnutrition can to some extent be an unintended side effect of economic development. For example, many countries finance their development plans by diverting resources to cash and foreign exchange-earning commodities at the expense of variety and richness of food crops. Agricultural development with improved technology displaces farm workers who migrate to nearby urban towns in search of jobs. Their nonfood expenditures on housing and transportation may compel them to spend less on food items. In conclusion, it can be said that education is now widely recognized as an investment but nutrition and health care are still viewed as humanitarian goals in many countries. There is a gradual realization that nutrition and health care are also investment tools with potentially high returns in the long run.

Increasing emphasis on the application of quantitative methods both to micro- and macroeconomic analysis has tended to reduce these socioeconomic systems to purely mechanical systems. These quantitative models are incapable of handling many qualitative aspects of human behavior in general and economic behavior in particular. These

models require many simplified and unrealistic assumptions. Many of the models of growth and development have these same limitations. One of the unrealistic assumptions of some growth models is the assumption of homogeneity of factors of production when they are subjected to marginal productivity analysis. This assumption might be rather realistic in preindustrial primitive economies where capital consists of simple tools and labor consists mostly of unskilled workers. Certainly this form of aggregation is highly unrealistic in advanced economies. Recent research on the economies of the United States, western Europe, Japan, and the Soviet Union showed that a large portion of their output was unexplained when the conventional classification of inputs into homogeneous physical capital and labor was used. This large so-called income "residual" in economic expansion led economists to attribute it to qualitative changes rather than quantitative changes of inputs. This led to major break-throughs in incorporating the quality aspects of physical capital into the analysis. A new argument developed with respect to the introduction of technical progress into the production function -- in embodied or disembodied form and in neutral or augmenting form. Models of growth theory, e.g., those developed by Hicks, Kaldor, Solow, Morishimna, and others, may be noted here. But the progress in incorporating the quality aspects of labor into the production function has not been satisfactory. The recent human capital approach has failed so far to take account of adequate nutrition as an ingredient of the quality of human capital. In this approach educational and job training are emphasized but not nutritional factors. Quality of the labor force may be a direct function of education and job training but it is in-

directly a function of nutritional and health status. So there is a great need to incorporate nutritional and health histories when measuring quality of the labor force in modern models of growth and development. Stone's (1954) linear expenditure system is found more suitable in growth models [Kelly, Williamson, and Cheethan, 1972].

One particular attempt to relate nutrition to economic growth is found in the works by Correa and Cummins (1970). They treat work capacity as a function of calorie consumption and derive its effect on the growth of national output. So far the research has succeeded in identifying and measuring output changes that can be attributed to labor productivity but it has failed to identify the changes that can be attributed to nutritional status. Generally, labor's potential productivity is a complex function of quantities and qualities of nutrients consumed by the worker, and the amount and quality of intellectual skill the worker has acquired through education and job training. In addition, actual productivity depends upon incentives and motivation. The relative importance of the quality aspects of capital and labor can be seen in the following observations by economists: (a) the size of the residual is relatively smaller in poor economies than in rich economies. It was estimated that about three-fourths of the growth in total output in the United States during postwar period could be attributed to the quality aspects of both physical and human capital; (b) the relative importance of the quality factors has been declining over time in poor countries because the growth process has been slowing down mainly due to the acceleration in population growth and malnutrition [Berg, Scrimshaw, and Call, 1971].

Human resource development and improvement in quality of life

of the total population of a country should not only be the final objective of development but also should be a mechanism for achieving a real and harmonious socioeconomic development; economic growth in terms of rate of growth of GNP and capital formation is only a means to those ends. Quantity without quality has little meaning. Demographers are expressing a great concern about the race that is going on between population growth and output (economic) growth in quantity terms and are expressing alarm that population is likely to win the race at least in poor countries. Here, also, quantity is the sole criterion. Japan, whose density of population is quite high, enjoys a fairly decent level of living that has been increasing rapidly. One reason is that emphasis has been placed on the quality of population and not the quantity of population. Quality considerations are important in every aspect of human life. It is the quality of human existence that should be the ultimate measure of development, and among the factors that influence human existence, nutritional status is a major determinant. The main task of econutritionists is to test the validity of hypothetical statements, such as nutritional improvement leads to motivational change and to an increase in labor productivity. This task requires quantification of many concepts and relationships in food, nutrition, health, and behavior of people. The better and the sooner the necessary efforts are put forth to solve nutritional problems, the easier it will be to accelerate economic progress.

Modern development thought is marked by trends toward more social relevance and community involvement. These ideas relate economic development more to levels of living -- to human happiness

perhaps than to purely economic terms such as the rate of GNP and capital accumulation. This approach emphasizes income distribution, agriculture, intermediate technology and social relevance or benefits such as improvements of quality of life in terms of living standards, employment, adaptive noninformal education, housing, health, and nutrition [Berg, Scrimshaw, and Call, 1971]. Both humanitarian reasons and the need to reach all levels of people necessitated this change of approach. Boerma, the Director General of FAO, in his address to the First Asian Congress of Nutrition strongly endorsed the World Food Congress plan for the "humanization of the whole development process" because, so far, purely economic considerations and not humanitarian ones have dominated the thinking with regard to the development process. Any plan to combat malnutrition requires frequent and significant changes in social, economic, cultural, and political structures of the country. Nutrition as a means or tool in this modern approach led planners to consider nutritional and health expenditures as investments and not as consumption drains on the economy. So the apparent conflict gave way to confluence. The reasons are simple: (a) the economic planner is certainly concerned with improvement of human resources -- that is, people who are also the concern of nutritionists; (b) the modern planner, more concerned with the quality of life and wider social benefits, is soliciting advice from others, including nutritionists; and (c) the modern planner has now realized that his decisions have nutritional implications. He now knows that nutritional improvements can be brought about by other ways such as improvements in communication, transport, storage, and price policies. The nutritionists have also realized

the economic benefits as well as the traditional health effects. This mutual re-examination of their mutual relationship has widened the role of the nutritionists and the planners and is opening a way to a systematic approach to the whole question of nutritional planning. So nutrition programs are gaining importance as a separate entity and as a theme running through many aspects of national development plans. Thus a general consensus on the need for a systematic and analytical approach, based on community data, is gradually emerging.

The need to collect information leading to an"econutritional profile" is felt. It is a new conceptual approach, welding nutritional and economic approaches. Ecological variations of programs of different regions of the world have been emphasized. The fact that there is no universal panacea for mulnutrition and that details vary greatly among countries and that some type of systematic approach is essential have gained considerable support in recent years. A promising beginning has been made in employing the correct and logical tool-systems analysis. The need for an integrated program, combining micro and macro elements, and indeed for "super macro" approaches to take account of global influences of trade policies, of prices of agricultural products, and of international food aid and the like, is greatly felt. So, in the days ahead the econutritionist, the nutritionally oriented economic planner, has a more significant and relevant role to play than do the isolated nutritionist and economic planner [Berg, Scrimshaw, and Call, 1971].

In the U.N. Second Development Decade, planners at an international level are stressing both economic advancement and humanitarian benefits in their approaches to development. This trend is

visible in individual countries, notably India and Sweden, where nutritional importance has been emphasized in their economic planning. There is a considerable emphasis on nutrition as a component of national development.

In summary, one can say that in earlier development thought, quantity and not quality, economic and not social or humanitarian benefits were emphasized. Some important development tools, such as nutrition and health care, were considered as goals and classed as welfare issues. In more recent thought with regard to development, both humanitarian and economic aspects are emphasized. Nutrition and health are also recognized as investment tools as well as humanitarian goals.

It can be argued or deduced that the malnutrition and under-nutrition problem is deeply rooted in the world economic situation and it can not be easily solved. It is only through the painfully slow process of development that the underfed, malnourished people of the world can reach the point where they will be able to afford better nutrition. The nutritionists have already warned us that before this point is reached it might be too late for millions who may never be able to realize their physical and mental potential. So the alternatives are (a) To apply all the available technological knowledge to the problem of food and nutrition; (b) To speed up production as fast as possible; (c) To arrange for proper storage of food resources and foods and for their marketing and distribution; (d) To expand quickly and operate efficiently all health services. All of these actions can improve the situation, but they do not attack the problem at its roots. The latter attack can be done only at the level of world wide

programs to develop the methods and measures of equalizing the opportunity to live the richer, fuller life to which every human being is entitled.

CHAPTER IV

NONNUTRITIONAL CONSIDERATIONS

All the factors underlying food habits can be classified into two categories: (a) those influencing availability and (b) those influencing acceptability of food. Acceptability considerations are germane only when food is available. Given that the foods are available, acceptability is a matter of natural selection. The availability considerations are mainly scientific and technological, geographic, economic, and to some extent political. Modern science and technology have made available to man a wide variety of foods whose acceptability has become a main consideration. Acceptability considerations are religious, cultural, psychological, economic and sensory. The nonnutritional considerations underlie acceptability of foods. To understand nutrition completely in all its aspects one needs a thorough knowledge of the complexity of its environment and it is here that the social scientists in general and economists in particular must research the interrelationships that exist between malnutrition and sociocultural environment. Information that enables one to understand malnutrition not only from the technical or clinical point of view but also from inside, that is, from the point of view of the people who suffer from it, is badly needed. Without this kind of understanding of nutrition problems, brilliant laboratory or clinical research on nutrition may become useless because of the inability to communicate with people

for whom help is intended. The food habits of a person are the characteristic and repetitive acts that he performs under the impetus of the need to provide himself with nourishment and simultaneously to meet an assortment of social and emotional goals. By the choice one makes, which becomes habit on repetition, one attempts to achieve such satisfactions as security, comfort, status, pleasure and enhancement of one's ego. Because of these emotional connotations of food habits, many persons often resist change. It is said that man can easily give up his language, dress, or even religion, but not his food habits.

In prehistoric times, man as a hunter and food gatherer developed an instinctive liking for raw meat and plant products as they were easily available to him in his immediate surroundings. These raw foods incidentally were nutritious and were not available in a wide variety. In the absence of variety, acceptability considerations did not have a place. Liking is largely a matter of being conditioned or accustomed to what is available. So in prehistoric times, what man ate was both what he liked and what he needed nutritionally. Today, availability of a wide variety of nutritionally rich and poor foods has given rise to a large number of acceptability factors which have created a gap between what one likes and what one needs nutritionally. That is, today what one eats is surely what one likes but it may not be what one needs nutritionally. Scientists believe that both humans and animals possess some selective capability with regard to food. More specifically, they believe that there is an innate sense which guides the choice of foods that provide the required nutrients and prevents the use of foods that are nutritionally poor and/or hazardous to health.

How and why has man deviated from his natural instinct for nutritional foods? The socializing process and civilization appear to be main causes of this deviation or gap. The scientists have found experimental evidence in support of this selective capability among children up to age two. This natural instinct in food choice seems to disappear gradually beyond age two, probably because the child then becomes sophisticated in food selection by the socializing process [Kramer, 1973]. Civilization cooperated with the socializing process to widen this gap. The need to preserve food appears to have been one reason for preferring burnt meat or fermented honey. As civilization advanced, man who depended much for his day-to-day survival on the flora and fauna within his control learned to preserve food. The discovery of fire made it possible to roast and boil foods. Baking, drying, salting and fermentation appear to have followed. His preservation methods appear to have given rise to a wide variety of flavors in food and beverages. The various plants such as cardamon, coriander, dill, fennel, origanum, garlic, onion, thyme, saffron, cumin, ginger, cinnamon, and cassia anise became known to him. Next to the need for food preservation, man's inherent curiosity, increasing leisure time and his aesthetic sense seem to underlie the increasing importance and variety of flavors in food processing and food preparation. Another factor underlying the evolution of flavors appears to be international trade which exposed nations to different food commodities and raw materials. The flavoring agents in India are a good example. Most of spices and additives that are now used for flavoring were originally used for masking unpleasant odors and for preventing quick decay. Lastly, the industrial revolution brought many changes. One important

change was the separation of food producers from consumers. The producers' objective was to process a uniform product at minimum cost with respect to output. The distance between producer and consumer was widened -- to thousands of miles in many cases. The consumer was screened by wholesale markets and supermarkets from exercising any direct influence on the processors or the producers. Only total sales and their variations over regional, religious, and cultural or ethnic groups were of much interest to producers, e.g., sausages for Milwaukee, hominy grits for the South, brown eggs for Boston, fish on Friday and turkey for Thanksgiving. The increased efficiency of food production and decreased attention to flavor appear to have been the dominant features of American food production and food processing between the World Wars. More recently, flavor reappeared as a dominant factor.

The nonnutritional factors can conveniently be discussed under five main categories:

(a) Those that depend on intrinsic sensory qualities of foods;

(b) Those that have a direct bearing on such matters as religion, superstition, and magic;

(c) Those that have a direct bearing on cultural and ethnic characteristics;

(d) Those that have a direct bearing on psychosocioeducational features; and

(e) Those that are economic in character.

The description of each of these categories is followed by a brief discussion of the possibility of incorporating each into the demand for food.

Sensory Quality

Sensory quality of any food has three main components -- appearance, texture, and flavor. It is observed in everyday life that people select their food on the basis of appearance, feel, taste, smell, and hearing, as well as nutrition. Ingestion of food occurs before the body is nourished. This ingestion of food is controlled by many physiological and psychological mechanisms. The sensory quality is thus related to nutrition as it affects general food acceptability and its intake. The mechanisms by which these sensory qualities influence human behavior are still unknown. Scientists do not yet know whether these qualities affect stimulation of taste buds and cells only superficially or whether they directly affect the physiological and psychological processes. Food appearance is a dominant factor in food selection. Then comes the tactile (feel) sense whereby food items are tested by fingers or fork. Odor is detected when food is sniffed. The sense of taste and sound become important only after these three senses are satisfied and the food is eaten. The blend of taste and smell in the mouth is commonly identified as flavor.

A housewife, before deciding to buy any fruit, will first consider its appearance, usually color and size. She avoids fruit which is wormy, moldy or misshapen. If the product passes this "eyeball" test, she squeezes them gently and eliminates those which do not "feel good." Then she tests them for smell by sniffing them in order to insure that they are not moldy or overripe or to insure the expected aroma. Once she is sure that they "look good," "feel good," and "smell good," she tests the taste and sound, if it is possible to eat a piece of it [Kramer, 1973].

A housewife can carry out these tests very easily in the case of unpackaged products such as raw fruits, but she cannot conduct such tests in the case of packaged items such as a bottle of wine. In such cases she depends on a particular brand which has the strong support of an expert -- "the master taster." In such situations consumers may pay premium prices for manufactured goods on the basis of the sensory evaluation of others, even though the product may conflict with one's own sensory preferences. The consumer is likely to buy the lowest priced product that passed the direct inspection tests of appearance, touch, fell, odor and taste. There is a strong tendency towards customary foods with familiar sensory qualities. Because of this tendency, many new products introduced differ only slightly from familiar ones.

These sensory qualities of food items have not been quantified and hence have not usually been introduced explicitly into demand functions. People differ markedly in the importance they attach to sensory pleasure in food. Keenness of sense is one of the determining factors but it is perhaps least important. The place of this sensory pleasure in food is determined by one's personality -- a complex result of sociocultural and environmental factors.

Religion

Some food attitudes have roots in strongly held religious values -- Orthodox Jews and Moslems avoid pork and Hindus avoid beef. Since religion nourishes the spirit, just as food nourishes the body, it is not surprising to learn that in many societies food habits are associated with religion. Food was used as offerings to gods. Those

foods offered to gods had a very important place in society. They constituted so-called "soul food" for the society. They played a very essential role in the ritual of religious ceremonial feedings. Usually some inspiration underlies these ceremonial feedings. Overeating in these ceremonies has actually overshadowed the spirit or inspiration behind the ceremonies. That is, very few people try to remember the actual inspiration or spirit that underlies the ceremonies. To most people these ceremonies are just occasions to enjoy special food and indulge in overeating. In many cases the inspiration or spirit behind ceremonial eating (or overeating) has its origin in superstition or magic. Lion fat is supposed to rid one of mysterious human poisonings; the flesh and heart of a lion is supposed to rid one of a bad cold. Some herbs are supposed to possess magical power. Some foods are used to ward off evil spirits, to protect one from the power of witchcraft, to cure some diseases, to quicken one's senses, to ward off old age, and to make one more beautiful. Hedgehog, an animal with a timid disposition and knees of weak oxen, were forbidden food for warriors in Madagascar. Eggs, a symbol of fertility, is a forbidden food to women in Ganda tribes as it is believed that women who eat eggs become licentious. Food superstitions, unlike food taboos, are unrelated to qualities of foods. These are discussed because they affect the acceptability of foods in society. Generally, the basis of the taboos is nonscientific and irrational even though some seem to have a scientific and rational basis. Nonavailability or limited availability of a food has sometimes been the cause of its being tabooed. Everything new and strange is potentially dangerous so a new food may be tabooed. Another basis for food taboos seems to be the belief that "we are what we eat."

That is, some qualities good or bad are believed to be associated with some foods. The taboos prohibit some food either to the entire population or to some individuals in the society on the basis of age, sex, religion, or hierarchial position in the social or religious system. The taboos have their origin in economic and sociocultural regulation and may acquire strong emotional overtones in the long run. In order to insure the strict adherance to these regulations, they are brought under religious prescriptions. The Sanskrit saying इष्टं धर्मेण योजयेत् (Ishtham Dharmena Yojayet), means associate what is desirable with religion (so that people will follow it strictly). Here the term "desirable" implies desirable from any point of view. Consumption of some foods may be symbolic of some major happening in religious history and thus its consumption as a way of demonstration of faith in that religion cannot be avoided. Jewish dietary laws are believed to be a protective device -- a device to protect a Jew from being absorbed into some other powerful religious group. This protective device was very essential for the Jews as they were very few in number and spread thinly almost everywhere in the world. This preserving the identity of a religious group played a role in food taboos of almost every religion. Camel meat, which was originally tabooed by the Jewish people, was later permitted when they accepted Christianity just to convert the heathen. It is believed that Mohammed did not ban camel flesh to distinguish his followers from the Jews but he did ban the drinking of alcoholic beverages to distinguish them from Christians [Kramer, 1973]. Other taboos over time were hardened into strict codes of cultural conduct and a few of them became sanctified as religious dogma.

Religious attributes may be incorporated as a qualitative variable affecting the nonnutritional component $q^{(2)}(p, m_f^{(2)}, H_i^s)$. That is, one H_i^s can be included as a qualitative variable to represent religion.

Cultural and Ethnic Factors

Cultural and ethnic customs and traditions are not as dogmatic as religious ones and hence are not so rigidly followed. They have a geographic basis. One finds more similarities than differences in foodways in different cultures and ethnic groups in a geographic area. In some cases differences are only in the names of the food items rather than in substance. For example, Far Eastern chapati, Middle Eastern pitta, and European pizza are very similar both in name and substance, while Mexican tortilla is different in name but similar in substance. Chinese eggroll, European blintz, and Mexican enchilada are very similar in substance. Similarly, one can find many examples of foods with similar basic substance but with different seasoning and additives because of their availability. Since cultural and ethnic customs and traditions have no dogmatic content, the ethnic foods are readily accepted in other groups. This is particularly so in "melting-pot" populations such as those that exist in the United States. In fact, the major source of newly prepared foods currently accepted by most of the U.S. population is ethnic foods.

Every society possesses a culture which is manifested in customs and traditions that designate socially appropriate or suitable ways of acting, thinking, and feeling. Culture is man's way of life. Because man internalizes cultural traditions, they become an

inseparable part of him. Very few persons realize to what extent they are both beneficiaries and victims of their cultural traditions. Culture guides and protects, but it also limits perspectives and actions. For example, all cultures recognize man's basic needs such as food, shelter, and sexual drive, and prescribe acceptable ways to meet these needs. Thus,culture dictates to a large extent the manner by which and the degree to which man's basic biogenic and psychogenic needs shall be met. Man's ideas of the connection between the food he eats and the state of his health are a direct result of the way he has been acculturated to view food. Much of the phenomenon of food faddism is a result of notions that eating certain foods will bring certain benefits which may not be true. The honey and vinegar cult that was prevalent in the past is an example. The movement of organic food also belongs to this category. Fortunately, there is a tendency for the American mind to be acculturated to view everything scientifically and hence these cults are rarely followed in this country. Since foodways are among the oldest and most deeply entrenched aspects of many cultures, they cannot be easily changed. Even if they are changed, they produce a further series of unexpected and often unwelcome reactions.

It is difficult to quantify these cultural and ethnic features. Attempts to incorporate them as cardinal variables in economic analysis have not been successful. In demand studies, different cultural or ethnic groups are incorporated as qualitative variables. Since cultural and ethnic factors often are associated with geographic areas, the use of regions as a qualitative variable in the nonnutritional component may explain some of the influence of cultural and ethnic factors on food demand. Also, since cultural differences

exist between urban and rural populations, the introduction of urbanization as a qualitative variable may explain some of the cultural influences on food demand. Thus, to account for various aspects of cultural influences, race or ethnic group, region, and urbanization can be used as separate qualitative variables to explain the nonnutritional component, $q^{(2)}$.

Social Factors

Evidence accumulated by behavioral scientists indicates that peoples' consumption patterns depend on their so-called "reference groups," which reflects the felt need for social affiliations. A reference group is a group of people that an individual keeps in mind when formulating his opinion, attitudes, and beliefs. That is, it is a group with which an individual wants to be closely identified. One may have several reference groups for different activities. Market research suggests that one of the main reference groups, as far as expenditure patterns are concerned, is a social class which is generally related to the occupation of the head of the household. Thus, occupational categories can be used as a qualitative variable to explain the nonnutritional component, $q^{(2)}$.

Two other very important social factors are the age and sex composition of the household. Age and sex are significant determinants of both nutritional and nonnutritional needs of the family. Past studies show that: (a) Families headed by a man and woman have slightly more complex food patterns than do families with a woman as the only head; and (b) A more reliable predictor of complexity of eating patterns was the number of adult females in the family -- the

higher the number of adult females in the family, the more complex the family diet [Gifft, Washbon, and Harrison, 1972].

Various ways have been suggested and used to incorporate age and sex composition of the family as a determinant of food demand. The simplest way is to ignore age and sex and consider only family size (head count) as an independent variable. Apart from ignoring the important age and sex composition, this approach generates multicollinearty because family size and family income are usually correlated. One way out is to convert the consumption figures to a per capita basis but this requires acceptance of the "homogeneity assumption." Whether the homogeneity assumption is reasonable or not depends on the nature of the commodity in question. For many commodities, the economies of scale in consumption are substantial and it is much more so with food products. Economies of scale in consumption are more likely to be significant for some food items, e.g., canned foods, but insignificant for others, such as beverages. Another method is to develop an "equivalent scale" and use it as a separate variable or as a deflator of family consumption and income.

The present study uses a "21-meal equivalent person" to convert the consumption figures to a per person standard. There are many difficulties in developing and using such standard scales. Since it is unlikely that one particular scale is suitable for all commodities or foods, the most appropriate adult scale clearly depends on the nature of the commodity in question. This desirability, in principle, of developing an adult equivalent scale for each commodity also suggests the desirability of deriving another scale for total expenditure or income. Then the problem of estimating specific and general

income coefficients (effects) associated with these scales becomes complicated and almost impossible. Prais and Houthakker (1955) suggested an iterative procedure -- iterations continuing until stable sets of estimates are derived. Unfortunately, the subsequent work of Forsyth (1960) suggests that the specific and income coefficients cannot be determined by iteration or any other manner because the number of independent parameters is usually insufficient to determine these coefficients. Another procedure is to make some arbitrary assumption about the values of income coefficients and then to estimate the specific coefficients. Prais and Houthakker (1955) assumed unity and Nicholson (1949) assumed zero for this coefficient. Another alternative, adopted by Forsyth (1960), is to ignore the distinction between specific and income coefficients and to be content with the "total effect" of an extra person of a particular type. A more fundamental objection from the point of view of the demand analysis is that all such scales are based on normative judgements rather than market (or consumer) behavior. Thus, the nutritionists may believe that children need more milk than adults and thus assign higher weights for children, but this does not help the market demand analyst unless the parents also believe it to be so and reflect this belief in their pattern of milk purchases.

Other social aspects include the age, education, and employment status of the mother. In many studies these features were found to influence the family diet. A younger housewife has a different food purchase pattern than an older housewife. Age of the homemaker is generally expected to be negatively correlated with dietary adequacy. The kind of food the housewife buys for her family depends

on whether or not she is employed. Working housewives tend to buy more processed and convenience foods than the nonworking housewife. Higher educational attainment of the homemaker generally has a beneficial effect on the family diet. Educated homemakers are more likely to overcome traditional food patterns and cultural barriers. The age, educational level and employment status of the homemaker can be incorporated as separate explanatory variables.

One cannot ignore the influence of the father whose presence predominates in the mealtime atmosphere. In most societies, man is the main bread earner or provider and the woman is the homemaker. Man's earnings may depend to some degree on how content he is with his family and the environment in general and with his food environment in particular. Thus, the wife is likely to know the likes and dislikes of her husband and to fix meals to his tastes. Previous studies show that a very high proportion of housewives do not serve frequently the meals disliked by the husband [Bryan and Lownberg, 1958]. But it is difficult to incorporate into demand analysis such special likes and dislikes of the husband. There are many emotional aspects of food which one cannot incorporate in demand studies. Children use food as an emotional weapon. Eating can also be associated with a desire for care, attention, and love and it can serve as a substitute for these desires. Also food has a role in emotional games. People use food as an emotional outlet for their anxiety, tension, frustration, unhappiness, irritability, disappointment, loneliness, or boredom. This emotional exploitation of food can be justified on the grounds of a substitute for more dangerous alternatives such as addiction to drugs and alcohol. These emotional aspects of the individual consumer are

difficult to quantify and to incorporate in demand studies.

Economic Factors

Some kind of relationship exists between man's needs and wants and his financial position. Economic conditions influence food choices very strongly. Relative importance of food, clothing, housing, material possessions, entertainment, health and education vary from family to family. Economic constraints are a barrier to the achievement of maximum nutritional well-being. Purchasing power is a major determinant in the quantity and quality of diets. Many of the social, cultural, and religious problems appear to have an economic basis. There is evidence that children, whose parents have less income, hold unskilled manual jobs, and have minimum education, perform less well in school and on intelligence tests than children whose parents have higher income, hold skilled technical or professional jobs, and have achieved higher educational levels. These differences in income, occupation, and education are widely used as indicators of variations in general styles of life which affect styles of child rearing and have nutritional implications. The economic situation affects food availability. Food availability to a society is affected by processing, storage, transportation, and distribution systems. Mass-media advertizing exerts a great influence on food demand. Advertising can also be included as a determinant of food demand. Mass-media advertising actually become the market itself. The supermarkets and stores are merely the distribution centers. People decide what to buy while watching television, listening to radios, and reading newspapers and magazines. Thus, the advertising expenditures constitute

an important determinant of food demand in general and its nonnutritional component in particular.

Implications for Nutrition Education

The magnitude and direction of the effects of the above factors on the nonnutritional component of food are valuable for the nutritional education of the people. "Prevention is better than cure" should be the philosophy of nutritional education, because, in terms of money, time, quality of life, and human resources, nutritional rehabilitation is more costly than prevention [Gifft, Washbon, and Harrison, 1972]. Preventive nutrition education needs two types of information: (a) Information on the effects of various nonnutritional factors on the nonnutritional component of food demand; and (b) The nutritive content of foods. Any purposeful attempt to influence food choices or attitudes towards food must combine the application of pertinent factual information mentioned above. At present, too little is known to frame precise nutritional educational programs. It is hoped that this study may aid in the designing of such programs. Attitudes, as psychologists say, are positive or negative dispositions toward a stimulus, whether these be objects (like foods), actions or ideas. Formulation of attitudes is a three-step process: cognition, effect, and action. If the nutrition educator's aim is to create desirable attitudes towards food, he must provide the consumer with some kind of information about food components (cognition) which first leads to consumers' evaluation of foods (effect), and then results in a positive or negative disposition towards foods (action). These three steps are highly interdependent and hence a change in any one leads to a change

in the other. Each step is very complex and affects attitude formation. For example, a negative attitude towards a new but nutritious food may be simply a fear of the unknown or unfamiliar because the unknown is considered as potentially dangerous. If the nutrition educator with factual information introduces the new food in a favorable setting, at least a willingness to taste and try may be gained. Willingness to change an attitude comes from the major motivation underlying attitude. There are three major bases of attitudes--knowledge, social adjustment derived from the norms of reference groups, and defense of ego. One or more of these may be important for an attitude. If an attitude is based primarily on knowledge, then the information that the knowledge is not accurate or correct may cause a change in attitude. When an attitude is based on social adjustments in terms of social norms, the right technical information alone is not sufficient. It must be accompanied by the support of group leaders to bring about a change in the attitude. But attitudes based largely on ego-defensive mechanisms are hard to change.

In summary, one can say that the study of the effects of non-nutritional factors, in terms of magnitude and direction on the non-nutritional component of food demand, can provide a good guide in nutrition education programs.

CHAPTER V

METHODOLOGY

The starting point of any econometric study is the formulation of an econometric model. The formulation embodies a set of hypotheses that can be tested statistically. In actual practice this process is not simple. A model is an abstract representation of a real world and as such it identifies what is relevant to a particular problem under consideration and abstracts from all other matters. Since basic economic theory tends to be quite general, the theory must be augmented to handle a specific empirical application. As a consequence, virtually every econometric study requires a set of specific hypotheses. These specific hypotheses (and simplifying assumptions) are convenient approximations of reality which depend on: (a) the subject matter area and intricacies of the problem under investigation, (b) the requirements of the statistical method to be used, and (c) the available data.

The choice of a statistical model also poses some problems. Most statistical techniques were devised for analysis of data generated by experimental techniques, particularly in the biological and physical sciences. Stricktly speaking, these techniques are not applicable in much of the economics research because most economic data are not generated by experiments. Economic observations rarely constitute an experiment as assumed in statistical theory. Other uncontrollable

factors sometimes obscure the performance of a particular relation in the model. Another difficulty with economic data is that one is quite often unable to achieve greater discriminating power by improving the experimental design. Under these conditions, the retention of a particular hypothesis depends on its intuitive appeal or plausibility.

However, the lack of experimental quality of economic processes does not justify the highly skeptical attitude some people have towards traditional statistical tests of significance. One must be far less exacting of economic data than of the experimental outcome of trials that are subject to experimental control or at least to a specific design. Lastly, economic evidence, as a rule, is equally compatible with a wide range of alternative hypotheses. Under these conditions, it is no surprise that econometrics has made greater progress in the estimation of parameters than in the testing of hypotheses. The present study is subject to all these problems and limitations.

Theoretical Model

General Considerations

In formulating the model, nutritional factors which are objective and universal and the nonnutritional factors which are subjective and specific are considered together with the economic factors. Traditional theory ignores factors such as household characteristics and concentrates mainly on the effects of income and prices on consumer demand. The present study tries to account for household characteristics because of their importance in food purchasing behavior. The so-called nonnutritional factors are largely associated with these household characteristics. As shown in Chapter II, Lancaster's approach to

demand theory ignores the subjective characteristics of goods and concentrates mainly on objective characteristics. The subjective characteristics of food (nonnutritional factors) are as important in food demand as the objective characteristics (or nutritional factors). Recently, there has been a shift from the investigation of better ways of making commodities to the investigation of making better commodities. This shift in production of goods has generated a desire on the part of consumers to think of how to consume goods more "efficiently." So the efficiency criteria of production economics have entered the domain of consumption economics. Both the traditional approach and the technological approach play a role in the model developed here.

According to psychological theory, a consumer buys a commodity because it satisfies his needs or desires which are broadly classified as biogenic and psychogenic. These biogenic and psychogenic needs correspond respectively to the nutritional and nonnutritional components of food demand. It is hard to quantify "the drive-cue-response-reinforcement" process of psychological theory. The best one can hope to do is to include the variables which underlie this process. So the model uses household characteristics as arguments of the utility function to represent these biogenic and psychogenic needs.

The behavioral assumption is that the consumer maximizes utility $U = U(q,H)$ subject to budget constraint $p'q = m_f$. This constrained maximization yields the demand functions;

$$q = q(p,\ m_f,\ H) \tag{5-1}$$

where q is an n-component vector of foods,

p is a vector of food prices,

$m_f = p'q$ is the consumers' food expenditure determined at the first stage of a multistage maximization process,

H is a set of household characteristics underlying the biogenic and psychogenic factors.

Let H^b be the characteristics which underlie biogenic needs and H^s be the characteristics which underlie psychogenic needs. Since biogenic or physiological needs are universal and objective, it is assumed that the biogenic component, $q^{(1)}$, is deterministic and forms an additive component of q:

$$q = q^{(1)}(p,\ B,\ H^b) + q^{(2)}(p,\ m_f^{(2)},\ H^s) \qquad (5\text{-}2)$$

where B is the consumption technology matrix and $q^{(1)}$ and $q^{(2)}$ are called biogenic (nutritional) and psychogenic (nonnutritional) components of q (or more idiomatically, "vitamin" and "sociomin" components of food demand).

The nonnutritional component alone is

$$q - q^{(1)} = q^{(2)}(p,\ m_f^{(2)},\ H^s) \qquad (5\text{-}3)$$

where $m_f^{(2)} = m_f - p'q^{(1)}$

For an individual commodity i,

$$q_i^{(2)} = q_i^{(2)}(p,\ m_f^{(2)},\ H_i^s) \quad i = 1, 2, \ldots, n \qquad (5\text{-}4)$$

where H_i^s consists of only those characteristics that are relevant to food i. $i = 1, 2, 3, \ldots, n$.

In expenditure terms (5-4) can be written as

$$e_i^{(2)} = e_i^{(2)}(\tilde{p},\ m_f^{(2)},\ H_i^s) \qquad (5\text{-}5)$$

where $e_i^{(2)} = p_i q_i^{(2)}$ and $\tilde{p} = p$ with p_i deleted.

If p can be assumed constant, (5-5) can be written as

$$e_i^{(2)} = e_i^{(2)}(m_f^{(2)},\ H_i^s) \qquad (5\text{-}5a)$$

As a special case, when the sample is homogeneous with respect

to household characteristics H^S, one can assume that a proportion of $m_f^{(2)}$, say $= \beta_i$, will be spent on the i^{th} food and write $e_i^{(2)}$, as:

$$e_i^{(2)} = \beta_i m_f^{(2)}; \; i = 1, 2, \ldots, n \tag{5-6}$$

Satisfaction of the budget constraint, $\sum_{i=1}^{n} e_i^{(2)} = m_f^{(2)}$ implies

$$\sum_{i=1}^{n} \beta_i = 1 \tag{5-7}$$

The expenditure system (5-6) with constraint (5-7) is Stone's (1954) linear system for all commodities for which $q_i - q_i^{(1)} > 0$. This expenditure system can be integrated into the Stone-Geary utility function [Geary, 1949-50 and Stone, 1954]. β_i emerges as a constant of proportionality of the nonnutrition component of the i^{th} food item $q_i^{(2)}$ which is given by:

$$q_i^{(2)} = \beta_i \frac{m_f^{(2)}}{p_i} = \frac{\beta_i}{p_i}(m_f - p'q^{(1)}) \; i = 1, 2, \ldots, n. \tag{5-8}$$

This expenditure system can also be derived another way. Consumer purchases can be viewed as a three-stage optimization process. In the first stage, total income is optimally allocated to various broad commodity groups of which food receives the amount m_f. In the second stage, $m_f^{(1)} = p'q^{(1)} (<m_f)$ is allocated optimally to the nutritional component $q^{(1)}$ in order to achieve a given nutrient intake z. In the third stage, the consumer allocates optimally his discretionary food expenditure $m_f^{(2)} = m_f - m_f^{(1)}$ to the nonnutritional component $q^{(2)}$. The third stage optimization is a traditional utility maximization problem. Specifically, $\max U = U(q^{(2)}, H^S)$

$$\text{s.t. } p'q^{(2)} = m_f^{(2)} = m_f - p'q^{(1)}$$

The solution yields demand functions for the nonnutritional component:

$$q^{(2)} = q_i^{(2)} (p, m_f^{(2)}, H^s) \text{ or}$$

$$q^{(2)} = q_i^{(2)}(p, m_f^{(2)}, H_i^s) \quad i = 1, 2, \ldots, n. \qquad (5\text{-}9)$$

which are equivalent to (5-4). Thus, the total consumption vector is the sum of the nutritional and nonnutritional components:

$q_i = q_i^{(1)} + q_i^{(2)}$ (or $e_i = e_i^{(1)} + e_i^{(2)}$ in expenditure terms).

The form of the demand functions ($q^{(2)}$) is determined by the form of utility function $U = U(q^{(2)})$. A desirable form of the utility function is one that yields demand functions in the form of a convenient expenditure system such as Stone's (1954) or Powell's (1966) linear expenditure systems. Preference for a linear expenditure system is based on the fact that, for the microlevel analysis performed here, the desired nutritional improvement within the economic constraints must result from some kind of reallocation of food expenditure among various foods — usually referred to as expenditure-switching behavior.

The second guiding factor in choosing the form of utility function is that once the amount $m_f^{(1)} = p'q^{(1)}$ is committed to meet nutritional needs, the remaining "discretionary" food expenditure $m_f^{(2)} = m_f - m_f^{(1)}$ has to be spent on $q^{(2)}$ according to the relative contribution of each food item to the achievement of nonnutritional objectives. The term "discretionary" is used because it is believed that the consumer has the discretion to spend this according to his psychosociocultural needs. Nonnutritional factors affect the distribution of this discretionary income among the various food items. The distribution depends on the relative nonnutritional importance of various foods as measured by the elements β_i of β. That is, discretionary expenditure $m_f^{(2)}$ is spent on $q_i^{(2)}$ in proportion to β_i. Thus,

$$e_i^{(2)} = p_i q_i^{(2)} = \beta_i m_i^{(2)} = \beta_i (m_f - p'q^{(1)}) \text{ or}$$

$$q_i^{(2)} = \frac{\beta_i}{p_i}(m_f - p'q^{(1)}) \quad i = 1,2,\ldots, n$$

$$q^{(2)} = (m_f - p'q^{(1)})\, \Delta_p^{-1}\, \beta \tag{5-10}$$

where Δ_p is a diagonal matrix with $p_1, p_2, \ldots p_n$ as diagonal elements. Therefore the utility function $U = U(q^{(2)})$ should yield a demand function of the following linear form:

$$p_i q_i = p_i q_i^{(1)} + \beta_i (m_f - p'q^{(1)}) \quad i = 1, 2, \ldots, n$$

$$\text{or } \Delta_p q = \Delta_p q^{(1)} + (m_f - p'q^{(1)})\, \beta, \quad \sum_{i=1}^{n} \beta_i = 1 \tag{5-11}$$

That is, expenditure on any food item equals the sum of nutritional and nonnutritional expenditures. The only utility function that gives this linear expenditure system is

$U = U(q^{(2)}) = \prod_{i=1}^{n} q_i^{(2)^{\beta_i}}, \quad \sum_{i=1}^{n} \beta_i = 1$, which is the Stone-Geary utility function [Geary, 1949-50, Stone, 1954].

Expenditure equation (5-11) is the expenditure equivalent of equation (5-8). Since $q_i^{(2)} = \frac{\beta_i}{p_i} m_f^{(2)}$ and $m_f^{(2)} > 0$ by our hypothesis, $q_i^{(2)} \gtrless 0$, accordingly, as $\beta_i \gtrless 0$, $i = 1, 2, \ldots, n$. β_i can be negative in this model.

The third stage optimization process is to maximize

$U(q^{(2)}) = \max \{ \prod_{i=1}^{n_1} q_i^{(2)^{\beta_i}}, \prod_{i=n_1+1}^{n} q_i^{(2)^{-\beta_i}} \}$ subject to the budget condition $p'q^{(2)} = m_f^{(2)}$, where n_1 equals the number of food

items for which $\beta_i > 0$ or $q_i^{(2)} > 0$ and $n_2 = n - n_1$ equals the number of food items for which $\beta_i < 0$ or $q_i^{(2)} < 0$.

As explained in Chapter II, there is no place for subjective characteristics, e.g., nonnutritional characteristics, in Lancaster's demand theory and no place for objective characteristics, e.g., nutritional characteristics, in the traditional demand theory. In the model used here, only the nonnutritional factors underlie the utility maximization process. The assumptions of the theory imply that $U_i > 0$ for all i. That is, maximization of utility $U(q^{(2)})$ is achieved within the budget set by increasing (decreasing) $q_i^{(2)}$ accordingly as $q_i^{(2)} > 0$ or $q_i^{(2)} < 0$, (i.e., accordingly, as $\beta_i > 0$ or $\beta_i < 0$). Therefore, maximization of $U(q^{(2)})$ implies the maximization of $\sum_{i=1}^{n_1} q^{(2)^{\beta_i}}$ for which $\beta_i > 0$, $q_i^{(2)} > 0$ and the minimization of $\sum_{i=1}^{n_2} q_i^{(2)^{\beta_i}}$ for which $\beta_i < 0$, $q_i^{(2)} < 0$. Hence $\beta_i < 0$ is permissible (unlike Stone's case).[1] When $q_i^{(2)}$, the nutritional component imposed independently of the budget constraint, exceeds q_i to yield $q_i^{(2)} = q_i - q_i^{(1)} < 0$, utility of $q_i^{(2)}$ increases when $q_i^{(2)}$ decreases. With the relaxed assumption that β_i can be negative, the linear expenditure system accomodates both inferior and complementary goods which are ruled out by Stone's (1954) linear expenditure system. In the present context, the term "inferior" refers to the inferiority of food from the nonnutritional viewpoint. If $\beta_i = 0$, then $q_i^{(2)} = 0$ which is taken to mean that food i is nutritionally efficient in consumption. The case of trivial nutritional efficiency may

[1] Hereafter, the terms Stone's system, Stone's case and Stone's situation refer to Stone (1954).

occur when $q_i^{(1)} = 0$ and $q_i = 0$ which means that food i neither enters the nutritional component nor is consumed. When the nonnutritional factors are exerting influence on food i, $\beta_i \neq 0$. If $\beta_i \neq 0$, food i is taken to be nutritionally inefficient meaning it has either a positive or a negative nonnutritional component. Since a positive or a negative β_i implies a positive or a negative $q_i^{(2)} = q_i - q_i^{(1)}$, food i is consumed more or less than what is dictated by pure nutritional efficiency criteria. Since demand for food i is given by $q_i = q_i^{(1)} + q_i^{(2)} = q_i^{(1)} + \frac{\beta_i}{p_i} m_f^{(2)}$, where $q_i^{(1)}$ is determined by nutritional efficiency criterion, food i is classified as:

economically nutritious or econutritious if $q_i^{(1)} > 0$

economically nonnutritious or econonnutritious if $q_i^{(1)} = 0$

normal, neutral or inferior according as $\beta_i \gtreqless 0$

econonnutritious and normal if $q_i^{(1)} = 0$, and $\beta_i > 0$

econonnutritious and neutral if $q_i^{(1)} = 0$ and $\beta_i = 0$

econutritious and normal if $q_i^{(1)} > 0$ $\beta_i > 0$

econutritious and neutral if $q_i^{(1)} > 0$ and $\beta_i = 0$

econutritious and inferior if $q_i^{(1)} > 0$ and $\beta_i < 0$.

Since $q_i = q_i^{(1)} + q_i^{(2)}$, and $q_i^{(1)}$ is a predetermined nutritional component, higher (lower) consumption of q_i implies a higher (lower) nonnutritional component $q_i^{(2)}$. For those foods that have high (low) nonnutritional qualities compared to their nutrition qualities, $q_i \gtrless q_i^{(1)}$ for a larger number of consumers so that $\beta_i \gtrless 0$ and the income elasticity (actually expenditure elasticity because m_f is food expenditure) $\eta_{im} = \frac{\beta_i}{w_i} \gtrless 0$, where $w_i = \frac{p_i q_i}{m_f}$ is the proportion of the budget spent on food i. Hence, food i is normal or inferior accordingly as

$\beta_i \gtrless 0$. Foods for which $q_i \approx q_i^{(1)}$ over most consumers imply $\beta_i \approx 0$ and $\eta_{im} \approx 0$ and hence food i is neutral. This includes the case where both $q_i = 0$ and $q_i^{(1)} = 0$. That is, the food meets neither a sociomin need nor vitamin efficiency. Accordingly, a normal (inferior) food is consumed in higher (lower) quantities because it has a desirable (undesirable) nonnutritional content relative to its nutrient content.

Computation of Uncompensated Price and Income Elasticities and Slutsky Substitution Effects

The demand equation for food i is:

$q_i = q_i^{(1)} + \frac{\beta_i}{p_i}(m_f - p'q^{(1)})$, where $q^{(1)}$ is the nutritional component as determined by some nutritional efficiency criterion. Here $q^{(1)}$ is assumed to be homogeneous of degree zero in prices and to be differentiable with respect to prices. Further symmetry of Slutsky substitution terms requires $q^{(1)}$ to satisfy $\frac{\partial q_i^{(1)}}{\partial p_j} = \frac{\partial q_j^{(1)}}{\partial p_i}$ $(i \neq j)$. Note that $q^{(1)}$ is a parameter in Stone's linear expenditure system and it will be a function (in case of unique optimal solution) or correspondence if it is defined to be an optimal solution of linear programming. Given below are the expressions for uncompensated price and income elasticities and Slutsky substitution effects together with their simplified forms in Stone's and linear programming situations. The derivation of these results for a general $q^{(1)}$ is given in Appendix A.

(a) Vector of income elasticities:

$$\eta_m = \Delta_w^{-1}\beta = (\beta_1/w_1, \beta_2/w_2, \ldots, \beta_n/w_n) \tag{5-12}$$

where $\eta_{im} = \frac{\partial q_i}{\partial m_f} \cdot \frac{m_f}{q_i}$, $w_i = \frac{p_i q_i}{m_f}$ = proportion of budget spent on food i.

(b) Own-price elasticities: $\eta_{ii} = \frac{\partial q_i}{\partial p_i} \cdot \frac{p_i}{q_i} = -1 + \frac{q_i^{(1)}}{q_i}$

$$(1 - \beta_i)(1 + \eta_{ii}^{(1)}) - \frac{\beta_i}{e_i} \{ \sum_{\kappa \neq i}^{n} e_\kappa^{(1)} \eta_{\kappa i}^{(1)} \} \quad i = 1,2,\ldots,n \quad (5\text{-}13)$$

where $\eta_{ij}^{(1)} = \frac{\partial q_i^{(1)}}{\partial p_j} \frac{p_j}{q_i^{(1)}}$ = price-elasticity of nutritional component $q_i^{(1)}$, $e_i = p_i q_i$ and $e_i^{(1)} = p_i q_i^{(1)}$

If $\frac{\partial q_i^{(1)}}{\partial p_j}$ is small (or actually zero as in Stone's case) (5-13) simplifies to:

$$\eta_{ii} = -1 + (1 - \beta_i) \frac{q_i^{(1)}}{q_i} \quad (5\text{-}14)$$

= -1 < 0 for econonnutritious food

= 0 for econutritious and neutral food

< 0 for econutritious and normal food

> 0 for econutritious and inferior food.

(c) Cross price elasticities:

$$\eta_{ij} = \frac{\partial q_i}{\partial p_j} \frac{p_j}{q_i} = \frac{-\beta_i e_j^{(1)}}{e_i} + (1 - \beta_i)\eta_{ij}^{(1)} \frac{q_i^{(1)}}{q_i} - \frac{\beta_i}{e_i}$$

$$\{ \sum_{\kappa \neq i}^{n} e_\kappa^{(1)} \eta_{\kappa j}^{(1)} \} \quad i \neq j \quad (5\text{-}15)$$

$$= \frac{-\beta_i e_j^{(1)}}{e_i} \text{ if } \frac{\partial q_i^{(1)}}{\partial p_j} = 0 \text{ (Stone's case)} \quad (5\text{-}16)$$

= 0 if food i is neutral or food j is econonnutritious

> 0 if food i is inferior and food j is econutritious

< 0 if food i is normal and food j is econutritious.

The three inequalities given immediately above imply that: (a) gross substitutability is possible between an inferior food and an econutri-

tious food, (b) gross-complementarity is possible between normal food and an econutritious food, and (c) any neutral food is independent of an any other food. Since an inferior food is necessarily an econutritious food, gross-substitutability is possible only among econutritious foods.

Slutsky substitution terms (s_{ij}) are given below:

$$\text{(a)} \quad s_{ii} = (1 - \beta_i) \frac{\partial q_i^{(1)}}{\partial p_i} + \frac{\beta_i(\beta_i - 1)}{p_i^2} (m_f - p'q^{(1)})$$

$$- \frac{\beta_i}{p_i} \left(\sum_{\kappa \neq i}^{\eta} p_\kappa \frac{\partial q_\kappa^{(1)}}{\partial p_i} \right) \qquad (5\text{-}17)$$

$$\simeq \frac{\beta_i(\beta_i - 1)}{p_i^2} (m_f - p'q^{(1)}) \text{ if } \frac{\partial q_\kappa^{(1)}}{\partial p_i} \simeq 0 \text{ for all } \kappa,$$

(Stone's case) (5-18)

$$\simeq (1 - \beta_i) \frac{q_i^{(1)}}{p_i} + \frac{\beta_i(\beta_i - 1)}{p_i^2} (m_f - p'q^{(1)}). \qquad (5\text{-}19)$$

$$\text{if } \frac{\partial q_\kappa(1)}{\partial p_i} = 0 \text{ for all } \kappa \neq i$$

$$= \frac{\partial q_i^{(1)}}{\partial p_i} + \frac{\beta_i(\beta_i - 1)}{p_i^2} (m_f - p'q^{(1)})$$

$$\text{if } \beta_i \frac{\partial q_i(1)}{\partial p_i} \simeq 0 \qquad (5\text{-}20)$$

Equation (5-18) implies $s_{ii} \lesseqgtr 0$ accordingly as $\beta_i \gtreqless 0$ since $|\beta_i| < 1$. That is $s_{ii} < 0$ for a normal food, > 0 for an inferior food. This is also true in equation (5-20) because $\frac{\partial q_i(1)}{\partial p_i} \leq 0$ and is very small for infinitely small price changes. In traditional theory in general and in Stone's system in particular, $s_{ii} < 0$ for every good

normal or inferior (inferior goods are, of course, ruled out by Stone's system). In the traditional model, a compensated price rise (fall) always leads to a fall (rise) in demand irrespective of whether the good is normal or inferior. This is true in this model only for normal foods. For an inferior food, a compensated price rise (fall) invariably leads to a rise (fall) in its demand. An inferior (nonnutritionally inferior) food happens to be a nutritionally efficient food and it is natural that nonnutritional considerations may compel one to decrease consumption of it when a price fall is compensated. Compensation for a price fall means one is deprived of some money. Another point of difference between the traditional model and the model used here is that in this model the income effect of an inferior food does not have to dominate the substitution effect in magnitude for the Giffen paradox to happen: $\frac{\partial q_i}{\partial p_i} = -q_i \frac{\partial q_i}{\partial m_f} + s_{ii}$ is always positive since both terms are positive in this model.

$$\text{(b)}\quad s_{ii} = (1 - \beta_i) \frac{\partial q_i^{(1)}}{\partial p_j} + \frac{\beta_i \beta_j}{p_i p_j} (m_f - p'q^{(1)}) - \frac{\beta_i}{p_i} \left(\sum_{\kappa \neq i} p_k \frac{\partial q_\kappa^{(1)}}{\partial p_j} \right) \text{ for } i \neq j \tag{5-21}$$

$$= \frac{\beta_i \beta_j}{p_i p_j} (m_f - p'q^{(1)}) \text{ if } \frac{\partial q_i^{(1)}}{\partial p_j} \simeq 0 \text{ for all } i \neq j \quad \text{(Stone's case)} \tag{5-22}$$

$$= (1 - \beta_i) \frac{\partial q_i^{(1)}}{\partial p_j} + \frac{\beta_i \beta_j}{p_i p_j} (m_f - p'q^{(1)}) \text{ if } \frac{\partial q_\kappa^{(1)}}{\partial p_j} = 0 \text{ for all } \kappa \neq i \tag{5-23}$$

$$\simeq \frac{\partial q_i^{(1)}}{\partial p_j} + \frac{\beta_i \beta_j}{p_i p_j} (m_f - p'q^{(1)}) = s_{ij}^{(1)} + s_{ij}^{(2)}$$

say, (5-24)

if further $\frac{\partial q_i^{(1)}}{\partial p_j}$ is so small that $\beta_i \frac{\partial q_i^{(1)}}{\partial p_j} \simeq 0$

as $|\beta_i| < |$.

Whatever may be the rational criterion which determines $q^{(1)}$, $\frac{\partial q_i^{(1)}}{\partial p_j}$ $(i \neq j)$ is expected to be negligibly small for infinitely small price changes. So s_{ij} tends to approach $s_{ij}^{(2)} = \frac{\beta_i \beta_i}{p_i p_j} (m_f - p'q^{(1)})$, Stone's situation. That is, $s_{ij} \simeq s_{ij}^{(2)}$ for small price changes.

$s_{ij} = s_{ij}^{(2)} > 0$ if both foods are either normal or inferior,

$= 0$ if at least one food is neutral,

< 0 if one food is normal and the other is inferior.

The first inequality implies that Slutsky substitutability is not possible between a normal food and an inferior food. The second inequality implies that a neutral food is independent of every other food -- normal, neutral or inferior. The third inequality implies that the Slutsky complementarity is possible only between a normal food and an inferior food. Results of gross and Slutsky complementarity, substitutability, and independence are summarized as follows:

Gross relatedness	Slutsky relatedness
1. Gross substitutability is possible only between an inferior food and an econutrious food.	1. Slutsky substitutability is possible among normal foods and among inferior foods but not between a normal food and an inferior food.
2. Gross complementarity is possible only between a normal food and an econutritious food. An econutritious food may not be an inferior food.	2. Slutsky complementarity is possible only between a normal food and an inferior food. An inferior food is necessarily an econutritious food.
3. Gross independence is possible between a neutral (or an econonnutritious) food and any other food.	3. Slutsky independence is possible between a neutral food and any food -- normal, neutral or inferior.

Thus far, interrelatedness of foods was discussed in a special case where $s_{ij}^{(1)} = \frac{\partial q_i^{(1)}}{\partial p_j} = 0$ so that $s_{ij} = s_{ij}^{(2)}$, the Slutsky substitution term of Stone's linear expenditure system. The case in which the nutritional component $q^{(1)}$ is assumed to be an optimal solution of a linear program is discussed next. That is, where $q^{(1)}$ is the least-cost diet to achieve a given nutritional intake z. Here, the arguments in support of two conclusions are given:

(a) If $q^{(1)}$ is a unique optimal solution, small price changes do not destroy its optimality. That is, $s_{ij}^{(1)} = 0$ for small price changes, as discussed above in the special case.

(b) If $q^{(1)}$ is not a unique optimal solution then small price changes may destroy the optimality of $q^{(1)}$, i.e., $s_{ij}^{(1)} \neq 0$. It is possible to determine the sign of $s_{ij}^{(1)}$ by examin-

ing the structure of the consumption technology matrix B, particularly the structure of its i^{th} and j^{th} columns b^i and b^j.

These two conclusions follow from the fact that the optimum solution to a linear programming problem occurs either at an extreme point of its convex feasible set, $K = \{q \mid Bq \geq z,\ q > 0\}$, in which case it is a unique optimum or at a set of extreme points in which case it is not a unique optimum as any convex combinations of these extreme points is also an optimum solution. The case of a unique optimum solution is more likely as the elements of rows of the consumption technology matrix B are less likely to be proportional to prices and hence there is less possibility that the hyper plane (representing objective function) $p'q^{(1)} = m_f^{(1)}$ coincides with any of the facets or edges of the feasible set intersecting at an extreme point. In other words, the slope of the objective function $p'q^{(1)} = m_f^{(1)}$ differs substantially from the slopes of facets (and hence edges) intersecting at an extreme point where a unique optimum occurs. Therefore, small price changes do not destroy the optimality of $q^{(1)}$ if it is a unique optimum. If $\Delta q^{(1)} \neq 0$, the sign of $\frac{\Delta q_i(1)}{\Delta p_j}$ for any given z, and p_i, $i \neq j$, depends on the structure of the consumption technology matrix in general, and the i^{th} and j^{th} columns, b^i and b^j, in particular. The structure of the two columns b^i and b^j, determines whether two foods i and j are nutritionally substitutes (similar), complements (dissimilar) or independent. The two foods i and j can be classified as nutritionally similar (substitutes), dissimilar (complements) or independent, accordingly as:

(a) high (low) elements of b^i are associated with high (low) elements of b^j,

or (b) high (low) elements of b^i are associated with low (high) elements of b^j,

or (c) otherwise, i.e., when neither (a) nor (b) hold.

In general the sign of the Slutsky substitution effect: $s_{ij} = s_{ij}^{(1)} + s_{ij}^{(2)}$ depends on whether: (a) the two foods i and j are nutritionally substitutes ($s_{ij}^{(1)} > 0$), independent ($s_{ij}^{(1)} = 0$) or complements ($s_{ij}^{(1)} < 0$), (b) whether they are nonnutritionally normal, neutral, or inferior ($s_{ij}^{(2)} \gtrless 0$), and (c) which of the two ($s_{ij}^{(1)}$ and $s_{ij}^{(2)}$) dominates the other in magnitude when they are of opposite sign. The following cases emerge:

<u>If</u>	<u>and</u>	<u>the two foods are</u>
(a) i and j are nutritionally substitutes, $s_{ij}^{(1)} > 0$	(a1) both are either normal or inferior, $s_{ij}^{(2)} > 0$	(a1a) substitutes, $s_{ij} > 0$
(a) i and j are nutritionally substitutes, $s_{ij}^{(1)} > 0$	(a2) one or both are neutral $s_{ij}^{(2)} = 0$	(a2a) substitutes, $s_{ij} > 0$
(a) i and j are nutritionally substitutes, $s_{ij}^{(1)} > 0$	(a3) one inferior and the other is normal, $s_{ij}^{(2)} < 0$	(a3a) depends on which dominates in magnitude
(b) i and j are nutritionally independent, $s_{ij}^{(1)} = 0$	(b1) both are either normal or inferior goods, $s_{ij}^{(2)} > 0$	(b1b) substitutes, $s_{ij} > 0$
(b) i and j are nutritionally independent, $s_{ij}^{(1)} = 0$	(b2) one or both are neutral, $s_{ij}^{(2)} = 0$	(b2b) independent, $s_{ij} = 0$
(b) i and j are nutritionally independent, $s_{ij}^{(1)} = 0$	(b3) one inferior and the other normal, $s_{ij}^{(2)} < 0$	(b3b) complements, $s_{ij} < 0$
(c) i and j are nutritionally complements, $s_{ij}^{(1)} < 0$	(c1) both are either normal or inferior goods, $s_{ij}^{(2)} > 0$	(c1c) depends on which dominates in magnitude

If	and	the two foods are
(c) i and j are nutritionally complements, $s_{ij}^{(1)} < 0$	(c2) either i or j is neutral, $s_{ij}^{(2)} = 0$	(c2c) complements, $s_{ij} < 0$
(c) i and j are nutritionally complements, $s_{ij}^{(1)} < 0$	(c3) one is inferior and the other is normal, $s_{ij}^{(2)} < 0$	(c3c) complements, $s_{ij} < 0$

Thus far the special case of equation (5-5a) is discussed. This equation in its general form is: $e_i^{(2)} = e_i^{(2)}(m_f^{(2)}, H_i^s)$ where H_i^s is the vector (set) of household characteristics that reflect psychosociocultural needs underlying nonnutritional component $e_i^{(2)}$. If H_{ij}^s is the j^{th} element (j^{th} characteristics relevant to food i) of H_i^s $i = 1, 2, \ldots, n$, and $j = 1, 2, \ldots, k$, k being number of household characteristics, one can analyze the nonnutritional component by regressing $e_i^{(2)}$ on $m_f^{(2)}$, $H_{i1}^s, H_{i2}^s, \ldots, H_{ik}^s$ and testing the significance of their contribution to the explanation of $e_i^{(2)}$. One can draw useful qualitative as well as quantitative conclusions based on the sign and magnitude of the estimates of regression coefficients. The richness of the analysis depends on how many of the household characteristics H_{ij}^s can be included. The most important ones are (a) household age and sex composition, (b) household social class, (c) household regional and urbanization factors, (d) age, education, and employment status of homemaker, (e) race or ethnic group, and (f) exposure of household to mass-media and advertising. The independent variables can be both qualitative and quantitative. The empirical model is, therefore, a multivariable analysis of a covariance model.

Empirical Model

For reasons already stated in Chapter I, only red meat, poultry, and fish products were included in the present study. The 1965-1966 household food consumption survey reports (No. 1-5) for the spring quarter provide data on average quantity (in pounds) per household per week and their money values (expenditures) in dollars of 42 meat, poultry, and fish products consumed in four regions -- North East (N.E.), North Central (N.C.), South (S) and West (W) and the United States as a whole. The figures were also grouped into Urban (U), Rural nonfarm (RNF), and Rural Farm (RF) classes. The definitions of these regions and urbanizations are given in Appendix B. Tables 8 and 9 of the documents report consumption in both quantity and expenditure terms for the 42 products. These figures are averages of consumption of households in each of the income-categories. Spring quarter data were chosen because: (a) the spring quarter consumption was found to be more representative of annual consumption patterns than were data in other quarters, and (b) the sample size was larger (75,000 households) than the other three quarters (2,500 households).

Let $\bar{q}_{lijk}$ and $\bar{e}_{lijk}$ be household average consumption figures in quantity and expenditure terms in the k^{th} income group of j^{th} region and i^{th} urbanization for the l^{th} food and each of these is arithmetic average of n_{lijk} households where:

$k = 1,2,\ldots,n_{ij}$ = number of observations (also number of income groups) in j^{th} region and i^{th} urbanization.

$j = 1,2,3,4$ regions - NE, NC, S, and W in that order.

$i = 1,2,3$ urbanizations U, RNF and RF in that order.

$l = 1,2,\ldots,42$ food products.

Each urban category has 12 observations for each region $n_{1j} = 12$ for $j = 1,2,3,4$. Both rural categories have 5 observations and for NE and W and 9 observations each for NC and S.

So $n_{ij} = 5$ for $j = 1,4$

$= 9$ for $j = 2,3$. where $i = 2$ or 3

The total sample consisted of $\sum_{ij}\sum n_{ij} = 104$ observations for each commodity. Prices $\bar{p}_{lijk} = \dfrac{\bar{e}_{lijk}}{\bar{q}_{lijk}}$ were computed for all l,i,j,k.

The average family sizes r_{ijk} in terms of an abstract unit equivalent to 21 meals per person was available from the reports. To adjust for differences in age and sex composition of households, consumption figures were converted to a per capita basis.

$\tilde{e}_{lijk} = \dfrac{\bar{e}_{lijk}}{r_{ijk}}$ is per capita expenditure for all l, i, j and k.

The nutrient intake vector z is an 11-component vector in this study. The 11 nutrients are:

z_1 = Food energy in calories,

z_2 = Protein in grams,

z_3 = Fat in grams,

z_4 = Carbohydrate in grams,

z_5 = Calcium in milligrams,

z_6 = Iron in milligrams,

z_7 = Vitamin A value in international units,

z_8 = Thiamine is milligrams,

z_9 = Riboflavin in milligrams,

z_{10} = Niacin in milligrams,

z_{11} = Ascorbic acid in milligrams.

Thus far the nutritional component $q^{(1)}$ has been defined as a food vector that most economically supplies quantities of nutrients equal to that supplied by the observed consumption vector q. That is, $q^{(1)}$ is such that $p'q > p'q^{(1)}$ and $Bq^{(1)} = Bq$. This definition is too broad. Instead, $\tilde{q}^{(1)}_{ijk}$ which is the optimum solution of the following linear program is used.

$$\begin{aligned} &\min: \bar{p}_{ijk}\ \tilde{q}_{ijk} \\ &\text{s.t. } B\tilde{q}_{ijk} \geq \tilde{z}_{ijk} \\ &\qquad \tilde{q}_{ijk} \geq 0 \end{aligned} \tag{5-25}$$

where $\tilde{z}_{ijk} \simeq B\tilde{q}_{ijk}$ and $\bar{p}_{ijk} = (p_{1ijk}, p_{2ijk}, \ldots, p_{42ijk})'$ is a 42-component price vector and $\tilde{q}_{ijk} = (\tilde{q}_{1ijk}, q_{2ijk}, \ldots, \tilde{q}_{42ijk})'$ is a per capita consumption vector in quantity terms.

Next, $\tilde{e}^{(2)}_{lijk} = \tilde{e}_{lijk} - e^{(1)}_{lijk}$ were computed for all l, i, j, and k.

where $\tilde{e}^{(1)}_{lijk} = \bar{p}_{lijk}\ \tilde{q}^{(1)}_{lijk}$ for all l, i, j, k.

To achieve homoscedasticity, the observations were transformed as follows:

$$y_{lijk} = \sqrt{n_{lijk}}\ \tilde{e}^{(2)}_{lijk} \text{ for all l, i, j, k} \tag{5-26}$$

$\tilde{e}^{(2)}_{lijk}$, the sample mean of n_{lijk} observations, has induced heteroscedasticity: $V(\tilde{e}^{(2)}_{lijk}) = \frac{\sigma^2}{n_{lijk}}$ if population from which this sample is drawn has variance $= \sigma^2$. So the empirical model is

$$y_{lijk} = \mu^{(1)} + b^{(1)} m_{fijk} + \alpha_i^{(1)*} + \beta_j^{(1)*} + \gamma_{ij}^{(1)*} + U_{lijk} \tag{5-27}$$

where $\mu^{(1)}$ is the overall mean of the 1^{th} food. $\alpha_i^{(1)*}$ is the effect of i^{th} urbanization, $\beta_j^{(1)}$ is the effect of j^{th} reason, $\gamma_{ij}^{(1)*}$ is the inter-

action effect between i^{th} urbanization and j^{th} region on consumption of the l^{th} food, and

$$m_{fijk}^{(2)} = \sum_{l=1}^{42} y_{lijk}$$

and U_{lijk} is a disturbance term. The regression equation (5-27) is not of full rank because of parametric constraints $\sum_i \alpha_i^{(1)*} = \sum_i \gamma_{ij}^{(1)*} = \sum_j \beta_j^{(1)*} = \sum_j \gamma_{ij}^{(1)*} = 0$. Reparametrization of equation (5-27), taking account of the above parametric constraints, is given by

$$y_{lijk} = \mu^{(1)} + b^{(1)} m_{fijk}^{(2)} + \alpha_i^{(1)} + \beta_j^{(1)} + \gamma_{ij}^{(1)} + U_{lijk} \qquad (5\text{-}28)$$

where
$$\alpha_i^{(1)} = \alpha_i^{(1)*} - \alpha_3^{(1)*} \qquad i = 1, 2,$$
$$\beta_j^{(1)} = \beta_j^{(1)*} - \beta_4^{(1)*} \qquad \text{for} \qquad j = 1, 2, 3$$
$$\gamma_{ij}^{(1)} = \gamma_{ij}^{(1)*} - \gamma_{34}^{(1)*} \qquad l = 1, 2, \ldots, 42.$$

U_{lijk} is assumed to be spherical. Under this specification ordinary least squares is applicable to equation (5-28).

The special case, where household characteristics are homogeneous, equation (5-6) with additive stochastic disturbance term can be written as follows in the notation of the empirical model:

$$y_{lijk} = \beta_{ij} \, m_{fijk}^{(2)} + U_{lijk} \qquad (5\text{-}29)$$

where $k = 1, 2, \ldots, n_{ij}$ for every pair i, j

$i = 1, 2, 3,$; $j = 1, 2, 3, 4$, and U_{lijk} is assumed to be spherical. The vector $\beta_{ij} = (\beta_{1ij}, \beta_{2ij}, \ldots, \beta_{42ij})'$ was estimated for various consumer groups arising out of combinations of i and j.

CHAPTER VI

EMPIRICAL RESULTS AND IMPLICATIONS

The results obtained from the empirical estimation of equation (5-29) are discussed and interpreted in this chapter. These results include (a) the β vectors, which are estimates of the discretionary or residual expenditure slopes and (b) percentage budget shares (100 w_i) and expenditure elasticities (η_{im}) for each food item.

$w_i = \frac{p_i q_i}{m_f}$ is the proportion of the total food expenditure spent on food i. $\eta_{im} = \frac{\beta_i}{w_i}$ is the expenditure elasticity $(\frac{\partial q_i}{\partial m_f} \cdot \frac{m_f}{q_i})$, for food i.

Based on economic efficiency arguments, the consumer chooses a nutritional component $q^{(1)}$ which has as much nutrients as the actual consumption vector q. But generally the consumer consumes $q \neq q^{(1)}$ so that some foods are overconsumed and others are underconsumed to yield a nonzero residual expenditure, $m_f^{(2)} = m_f - p'q^{(1)}$, which reflects nutritional inefficiency. This nutritional inefficiency is shared positively (negatively) by the overconsumed (underconsumed) foods. The sign and magnitude of β_i shows the extent to which food i is over or underconsumed, i.e., β_i is positive (negative) for overconsumed (underconsumed) foods. For an overconsumed (underconsumed) food i, w_i will have a relatively higher (lower) value so that the effect would be to decrease (increase) the value of η_{im}. Some values of η_{im} may be very

large if the corresponding w_i values are very small.

Since $w_i \geq 0$, the sign of β_i determines the sign of η_{im}. Foods whose expenditure elasticities are positive, zero, or negative are referred to as normal, neutral, or inferior foods, respectively. Food items whose expenditure elasticities are positive (negative) may be referred to as over (under) consumed from the standpoint of the nutritional component and the difference is attributed to nonnutritional factors. Foods whose expenditure elasticities are zero, or not significantly different from zero, are neutral, i.e., expenditure and consumption are consistent with the nutritional component. Thus food i may be termed:

(a) "more superior" if η_{im} is positive and > 1

(b) "barely superior" if η_{im} is positive and = 1

(c) "less superior" if η_{im} is positive and < 1

(d) "neutral" if $\eta_{im} = 0$

(e) "less inferior" if η_{im} is negative and > -1

(f) "barely inferior" if η_{im} is negative and = -1

(g) "more inferior" if η_{im} is negative and < -1.

Results of the covariance analysis of equation (5-27), i.e., the nonnutritional component in terms of household characteristics, are also discussed. These results include the coefficient of multiple determination (R^2) and its level of significance; the coefficients for regional effects (β_j), residence (urbanization) effects (α_i), the interaction between regional and residence effects (γ_{ij}), and residual expenditure. Estimates of the standarized β values are also included in the results.

Consumers were classificed into three residential (urbanization)

groups and four geographic regions of the United States. The purpose of the regional-residential classification of consumers was to test, in an aggregative manner, for effects of cultural, ethnic, and other characteristics on meat purchases. The food items include 42 products of red meat, poultry, and fish (Table 6-1).

Tests of Hypotheses and Summary of Results

Residual food expenditure slopes for each of the 42 meat items (β coefficients) by residential (urbanization) class within regions are given in Appendix C, Tables C-1 through C-5, and these results are summarized in Table 6-2. The percentage of the total food expenditure spent on each item and the expenditure elasticities for regional-residential classes are given in Appendix C, Tables C-6 through C-10 and these results are summarized in Table 6-3.

The food items were ranked according to the number of times, in the 104 possibilities, that each item entered the minimum cost diet. Results are given in Table 6-4.

The major hypotheses were as follows: (a) nutritional inefficiency exists in food purchases, i.e., there is a positive residual expenditure for food ($m_f^{(2)} > 0$); (b) nutritional and nonnutritional factors are competitive; and (c) the importance of total (or residual) food expenditure spent on the nonnutritional component ($e_i^{(2)}$) will increase as total (or residual) expenditure increases.

The first hypothesis is supported directly by the fact that expenditure in each of the 104 consumer units was in excess of that for the minimum cost diet. Additional empirical support is supplied by the large number of significant positive β values (residual

Table 6-1. Food code numbers and description

Code number	Description
	Beef steak
1	Round, including minute, cube, swiss.
2	Sirloin.
3	Porterhouse, also club, T-bone.
4	Other: chuck, flank, rib, delmonico, tenderloin.
	Roast beef
5	Chuck, also brisket, california, cross-cut, pot roast, shoulder.
6	Rib
7	Round
8	Rump, also top sirloin, sirloin tip.
9	Stewing, also boiling beef for soup.
10	Corned, chipped, dried, also pastrami.
11	Ground, including beef with pork, veal, or other meat.
	Other beef
12	Raw, plate beef, shank, short ribs, oxtails, stewing, boiling and soup beef with bone.
13	Canned
	Cooked
	Fresh pork
14	Chops
15	Ham
16	Loin
17	Sausage
18	Other: Boston butt, picnics, shoulder, steak, neck bones, pigs feet, spare ribs.
	Cured smoked pork
19	Ham, including sliced boiled ham.
20	Bacon
21	Salt pork, including fat back, side port, streak of lean, also cracklings, fresh jowls, pork skins.
22	Other: Boston butt, Canadian bacon, shops, ham hocks, loin roasts, picnics, pickled pork products, sausage.
23	Canned cooked pork; including ham, bacon, sausage

Table 6-1 (Continued)

Code number	Description
	Veal
24	Chops, cutlets.
25	Roast
26	Stewing ground, also breast, plate, patties, mock "chicken" legs, veal for soups.
	Lamb
27	Chops, steaks.
28	Roast
29	Stewing ground, also breast, shank, patties, lamb for soup.
	Variety Meat
30	Liver
31	Other: brains, chitterlings, kidneys, lungs, tongue, tripe, poultry giblets.
	Lunch meats
32	Frankfurters
33	Canned
34	Not canned
	Poultry
35	Chicken, including canned, frozen, cooked.
36	Turkey, including canned, frozen, cooked.
37	Other: cornish game hen, duck, goose, guinea, pheasant, quail, squab, other game birds.
	Fish
38	Fresh, also home-canned and home-frozen, cooked, roe, frog legs, turtle.
39	Frozen, commercially.
40	Canned, salmon.
41	Canned tune
42	Shell, including canned, frozen and cooked.

expenditure slopes) shown in Tables C-1 through C-5 and summarized in Table 6-2 and by the large number of popular items, especially beef and chicken, that did not appear in the economically nutritious foods as given in Table 6-4. At the U.S. level, 32 of the 42 food items (76.2 percent) had positive β values that were significantly different from zero at the 5 percent level. This very high proportion of over-consumed foods may be a result of the fact that only meat items were considered. Outside the meat category, it is possible that a higher proportion of food items were underconsumed from a nutritional standpoint.

The second hypothesis is supported by the results summarized in Table 6-4. With the exception of sirloin steak, those items that entered the least cost diet most frequently had the highest number of negative β values, i.e., those items were most frequently under-consumed. For example, liver entered each of the 104 minimum cost diets and all 12 coefficients were negative and 10 were significant at the 5 percent level. Further evidence in support of this hypothesis may be found by examining the reuslts in Table 6-3.

The third hypothesis, i.e., that as the level of food (or residual) expenditure increases the proportion spent on the nonnutritional component increases, is also supported by the empirical results. The results of the covariance analysis, discussed subsequently, add support to this hypothesis. The estimates of the coefficients of residual (or total) expenditure are positive for normal foods and generally negative for inferior foods. The nonnutritional factors exert a greater influence, in the respective positive and negative directions, at the higher expenditure levels. Additional support was

Table 6-2. Number of β coefficients that were significant at the 5 percent level

Food code	Region by residence (12)[a]	Regions (4)[a]	Residence (3)[a]
	Beef		
1	12	4	3
2	9	4	3
3	11	4	3
4	9	4	3
5	11	4	3
6	6	4	3
7	8	4	3
8	7	4	3
9	4	2	1
10	9	4	3
11	11	3	3
12	6	3	3
13	4	3	2
	Pork		
14	10	4	3
15	4	2	1
16	7	4	3
17	9	4	3
18	8	2	1
19	10	4	3
20	7	4	3
21	(5)	(3)	(2)
22	8	4	1
23	10	4	3
	Veal		
24	6	4	3
25	3	2	3
26	3	4	2
	Lamb		
27	4	4	3
28	4	4	3
29	(0)	(0)	(1)
	Variety meats		
30	(10)	(4)	(2)
31	3(2)	(2)	(2)
	Lunch meat		
32	10	4	3
33	8	3	2
34	11	4	3
	Poultry		
35	8	3	2
36	2(1)	(2)	(2)
37	3	2	2
	Fish		
38	11	4	3
39	6	1	1
40	(5)	(4)	(1)
41	10	4	2
42	8	4	3

[a]Total number of coefficients; other figures in parenthesis show the number of significant negative coefficients.

Table 6-3. Frequency distribution of foods among the nonnutritional categories for 12 regional-residential consumer groups[a]

Food item	Nonnutritional category					
	More superior	Barely superior	Less superior	Neutral	More inferior	Total
	Frequency					
Beef steak:						
1. Round	12	-	-	-	-	12
2. Sirloin	2	-	7	3	-	12
3. Porterhouse	5	-	5	2	-	12
4. Other	7	-	2	3	-	12
Roast beef:						
5. Chuck	11	-	-	1	-	12
6. Rib	1	-	6	5	-	12
7. Round	-	-	8	4	-	12
8. Rump	2	1	4	5	-	12
9. Stewing	-	-	4	8	-	12
10. Corned, etc.	2	1	6	3	-	12
11. Ground	11	-	-	1	-	12
12. Other beef, raw	1	-	5	6	-	12
13. Beef canned, cooked	1	-	4	7	-	12
Fresh pork:						
14. Chops	9	-	1	2	-	12
15. Ham	-	-	4	8	-	12
16. Loin	-	-	7	5	-	12
17. Sausage	5	1	3	3	-	12
18. Other	2	-	6	4	-	12
Pork cured, smoked:						
19. Ham	10	-	1	1	-	12
20. Bacon	7	-	-	5	-	12
21. Salt pork	-	-	-	7	5	12
22. Other	1	1	6	4	-	12
23. Pork canned, cooked	-	-	9	3	-	12

Table 6-3 (Continued)

Food Item	Nonnutritional category					
	More superior	Barely superior	Less superior	Neutral	More inferior	Total
	Frequency					
Veal:						
24. Chops, cutlets	1	–	5	6	–	12
25. Roast	–	–	2	10	–	12
26. Stewing	–	–	3	9	–	12
Lamb:						
27. Chops, steak	1	1	2	8	–	12
28. Roast	–	–	4	8	–	12
29. Stewing	–	–	–	12	–	12
30. Liver	–	–	–	2	10	12
31. Other variety meat	–	–	1	9	2	12
32. Frankfurters	10	–	1	1	–	12
33. Lunchmeat canned	2	3	3	4	–	12
34. Lunchmeat not canned	11	–	–	1	–	12
35. Chicken	7	–	–	5	–	12
36. Turkey	–	–	1	9	2	12
37. Other poultry	–	1	2	9	–	12
38. Fish, fresh and home processed	7	–	4	1	–	12
39. Fish frozen	–	1	4	7	–	12
40. Canned salmon	–	–	–	7	5	12
41. Canned tuna	10	–	–	2	–	12
42. Shell fish	5	1	2	4	–	12
Total	143	11	122	204	24	504

[a]Three residential groups within each of four regions.

Table 6-4. Economically nutritious foods[a]

Food code	Description	Rank based on the frequency of entrance in nutrition component	Actual frequency of entrance in 104 possibilities	No. of negative β coefficients out of 12 consumer groups: Total	No. of negative β coefficients out of 12 consumer groups: Significant at 5% level
30	Liver	1	104	12	10
21	Salt pork	2	90	12	5
2	Sirloin steak	3	79	–	–
40	Salmon, canned	4	75	11	5
29	Lamb, ground	5	20	5	–
31	Other variety meat	5	20	10	2
36	Turkey	6	19	10	1
35	Chicken	7	18	1	–
39	Fish, frozen	8	9	3	–
18	Other fresh pork	8	9	2	–
20	Bacon	9	5	–	–
9	Beef stew	10	3	3	–
11	Beef, ground	10	3	–	–
15	Ham	10	3	3	–
22	Other cured pork	10	3	–	–
8	Beef roast, rump	11	2	–	–
12	Other raw beef	11	2	–	–
16	Pork loin	11	2	–	–
26	Veal, ground	11	2	–	–
13	Beef, canned	12	1	1	–
17	Sausage	12	1	–	–
32	Frankfurters	12	1	–	–
33	Lunch meat, canned	12	1	1	–
41	Tuna, canned	12	1	1	–

[a]An economically nutritious food is one that entered at least one of the 104 minimum cost diets computed for the 104 observations.

also found in that the expenditure elasticities (η_{im}) were positive and significant at the 5 percent level for 30 (71 percent) of the 42 food items. (See Tables C-6 through C-10 and Tables 6-2 and 6-3.) While there were small variations, the predominance of positive elasticity coefficients occurred in each of the region-urbanization groups.

Residual Expenditure and Expenditure Elasticities for Individual Meat Items

Beef Products: Items 1 Through 13

Sirloin steak (79 cases) is the only beef product that entered the minimum cost diet more than three times in the 104 observations (Table 6-4). For beef products in general, the residual expenditure slopes and the expenditure elasticity coefficients were positive and among those with the highest values. This pattern was found among regions and among residence classes. In general, a high preference for beef by U.S. consumers is indicated. These results are consistent with U.S. aggregate data that show increases in per capita consumption over time and with studies that have shown a relatively high income elasticity of demand for beef. The high coefficients for ground beef may be related to the convenience of hamburgers throughout the United States.

Pork Products: Items 14 Through 23

The coefficients for cured ham and bacon, and fresh pork chops, were relatively high and positive -- both for residual expenditure slopes and elasticities -- although somewhat below those for ground beef and round steak. With the exception of salt pork, the remaining pork products had positive but relatively small coefficients and two were not

significantly different from zero in the national aggregate. The coefficients for salt pork were mostly negative and there were substantial differences among regions. This item is often used as a seasoning rather than a main course food item. Thus, in general, the nonnutritional component was lower in pork than in beef.

Veal Products: Items 24, 25, and 26

In the aggregate for the U.S., the veal coefficients were positive and significant but were very small in magnitude in comparison with the major beef and pork products. Thus, the nonnutrition component was positive but relatively small. In some subgroups the coefficients were not significantly different from zero.

Lamb Products: Items 27, 28, and 29

The coefficients for lamb chops, steaks, and roast were positive but relatively small, while the coefficients for other lamb products were negative. Thus the nonnutritional component of lamb appeared to be very small or negative and was not significantly different from zero in a number of subgroups.

Variety Meats: Items 30 and 31

The variety meats consist of liver (No. 30) and brains, chitterlings, kidneys, lungs, tongue, tripe, and poultry giblets (No. 31). Of all the items included in this study, liver has the highest negative coefficients -- both slopes and elasticities. Moreover, it entered each of the total of 104 minimum cost diets. Thus, liver was underconsumed in relation to its price and nutritive value. Item number 31 generally had negative but relatively small coefficients.

Lunch Meats: Items 32, 33, and 34

The coefficients for lunch meats were positive and rather high for uncanned meats and frankfurters. For uncanned lunch meat the coefficients were about equal to that of round steak. These high coefficients probably reflect a high level consumption of meat sandwiches.

Poultry: Items 35, 36, and 37

The coefficients for chicken were positive and high; in most cases they were above those for the most popular beef items. On the other hand, the coefficients for turkey were negative at the U.S. level and negative or not significantly different from zero in certain subgroups. Coefficients for other poultry products (No. 37) were positive, but either very small or not significantly different from zero. The extensive marketing system for fried chicken that is ready to eat may have contributed to the large nonnutritional component of chicken.

Fish: Items 38 Through 42

The coeffcients, at the U.S. level, were negative, but relatively small for canned salmon, not significantly different from zero for frozen fish, and positive but relatively small for the other fish products. The largest positive coeffcients were for fresh fish and canned tuna.

Analysis of Covariance of Region and Urbanization Effects on Expenditures

In this section results of the analysis of covariance equation (5-27) are presented. Two sets of analyses were conducted. In the first, residual expenditure, $m_f^{(2)}$, was the covariate and in the second total food expenditure, m_f, was the covariate. There was very little

difference in the results for each covariate. For this reason the model with residual (or discretionary) expenditure as the covariate is discussed. The results of the analysis with residual expenditure as the covariate are given in Tables C-11, C-12, and C-13 of Appendix C. With the exception of frankfurters, the region and/or urbanization effects were significant for all items that had high and positive residual expenditure coefficients. These items included round steak, porterhouse steak, other steak, chuck roast, ground beef, beef chops, pork chops, bacon, uncanned lunch meats, and chicken. Neither region nor urbanization effects were significant for those items with high and negative residual expenditure coefficients with the exception of salt pork for which both effects were significant. The R^2, regional, and urbanization effects were insignificant for six items -- roast beef rib, roast beef stewing, other raw beef, canned and cooked beef, fresh pork ham, and ground lamb for stewing.

Policy Implications

The policy implications may be considered from the standpoint of serving consumers' interests through three main channels: (a) competitive market process, (b) economic legislation and market regulation, and (c) consumer education. This study provides the kind of information that is basic and useful to food and nutrition programs whether they are educational or action programs such as: (a) development of formulated (synthetic) foods, (b) enrichment of foods by fortification, (c) producer incentives, (d) consumer incentives, and (e) improvements in food distribution and marketing systems.

The purpose of nutrition education is to aid consumers in

understanding the nutritional and socioeconomic values of food and how the market process affects their well-being. Such education also attempts to explain the consequences of alternative sets of values when there is a conflict between nutritional and nonnutritional components. In this study the nonnutritional component was analyzed in terms of consumer values reflected by household characteristics H^s.

The results of this study make it possible to classify foods into three categories: (a) normal foods which are superior nonnutritionally in the sense that they are overconsumed, (b) inferior foods which are inferior nonnutritionally in the sense that they are underconsumed, and (c) neutral foods which are neither overconsumed nor underconsumed. Since neutral foods are nutritionally efficient in consumption in the sense that the nonnutritional component is very small or zero, nutritional improvement policies should be directed mainly to normal and inferior foods. Nutritional improvement in the consumption of a normal (inferior) food comes from reducing (increasing) its nonnutritional component, $q_i^{(2)} = q_i - q_i^{(1)}$. The reduction of $q_i^{(2)}$ for a normal food can be achieved either by decreasing its consumption, q_i, or by increasing its nutritional component, $q_i^{(1)}$. To increase $q_i^{(1)}$, one has to recommend a reduction in its price, an improvement in its nutritive quality or food fortification. To decrease $q^{(2)}$ through a reduction in actual consumption requires knowledge of the magnitude and sign of the coefficients in the regression of $q^{(2)}$ (or $e^{(2)}$) on household characteristics H_j including expenditure or income. If the estimate of the coefficient $\alpha_{ij} = \frac{\partial q_i^{(2)}}{\partial H_j}$ is significant and positive (negative), then attempts should be made to change the attitudes of households that

have the attributes that contribute to the higher values of H_j through nutritional education. An increase of $q_i^{(2)}$ for an inferior food can be achieved by encouraging its consumption through nutritional education.

The relative importance of these nonnutritional factors and the support of the third hypothesis casts doubt on whether higher incomes are a solution to nutritional problems. In the past, economic factors (particularly low income) have been blamed for nutritional ills. This is no surprise because the traditional demand functions depend only on economic factors -- prices and income. Income surely is a major determinant of nutritional intake or status. But the claim that increasing income leads to nutritional improvements is questionable. Increased income may increase food expenditure but increased food expenditure does not necessarily mean nutritionally better diets. Results of this study show that the relative economic efficiency with which additional units of nutrients are consumed declines with increased food expenditure for normal or inferior foods. That is, nutritional inefficiency is an increasing (decreasing) function of residual (and total) food expenditure for nonnutritionally superior (inferior) foods. Indirect support for this phenomenon is also available. Generally, nutritional efficiency, in the sense of a higher number of neutral foods and/or lower residual expenditure, was observed to be higher for rural families than for urban families. It is generally known that incomes of rural families are low in relation to incomes of urban families. This result is in accordance with Maslow's (1943) hierarchy of needs. Once the minimum nutritional needs are met, consumers try to satisfy other nonnutritional (higher in hierarchy) needs by consuming more econonnutri-

tious foods and less econutritious foods. This type of behavior means that, after a certain stage, economic incentives may actually reduce nutritional efficiency in food consumption unless there is an effective educational program.

Thus far, the desirability of reducing the absolute size of the nonnutritional component in order to increase economic efficiency of nutritional intake has been discussed. Some people doubt that such programs would be effective. Can people be persuaded to modify their food habits? Surely they can be persuaded to do so with dedicated efforts. Two striking examples are the current regular consumption of orange and tomato juices which were disliked and not consumed in earlier years. It is said that most of the variation in food tastes is due to different degrees of habituation and differences in conditioning. If a consumer fails to appreciate and eat a potentially econutritious food, it is because of lack of habituation. If he desires, he can remedy this situation. It is here that nutritional education can help persuade the consumer to alter habitual behavior. If this lack of appreciation for econutritious food requires some form of sociocultural conditioning, it can be provided through nutritional education programs. Taste for anything -- be it an art or a food -- is a matter of cultivation. Experience and conditioning are the most important factors in food appreciation. So it is believed that food habits can be changed to enhance nutrition. It may not be possible to fully achieve this objective and it may not be socially economical to do so. Stigler (1961, p. 224) once remarked that consumer ignorance is like subzero weather and "By a sufficient expenditure its effects upon people can be kept within tolerable or even comfortable bounds, but it would be wholly uneconomic to entirely eliminate all its effects."

CHAPTER VII

SUMMARY AND CONCLUSIONS

Problem

Despite the fact that food has attracted both scientific and humanistic interests for centuries, there are a large number of important questions that have not been answered. Food plays a very fundamental role in the struggle for survival, but it has taken on significance in human society beyond that of nourishing the body. The roles that food plays outside the nutrition area are reflected in patterns of human behavior. Our understanding of consumer behavior has evolved over many centuries in which the primary aspects of consumer welfare were physical and economic survival and security, the top two needs in Maslow's (1943) hierarchy of human needs. For the most part, only economic factors -- prices and income -- entered traditional demand functions and these variables went a long way toward explaining the purchase behavior in general and food purchase behavior in particular. The psychosociocultural and religious aspects of purchase behavior, which underlie the other steps in Maslow's (1943) hierarchy, did not surface because of the low levels of living in the past. Today, man's objectives go beyond physical and economic survival. A very complex set of factors surround human behavior in general and food behavior in particular. Two sets of variables, quantity and quality of food and quantity and quality of environmental stimulation,

which includes the nonnutritional environment, determine the total mental and physical well-being of a person. A fundamental and important problem in attempts to understand and explain human behavior is how to isolate personal values from the scientific facts. This problem certainly exists in the case of food purchase behavior. Of interest in this study are the nutritional and nonnutritional components of demand for food. The factors affecting the demand for food were classed as: economic (e), as reflected in prices and income; nutritional or biogenic (H^b), as reflected in biogenic characteristics; and nonnutritional (H^s) as reflected in social or psychogenic characteristics. A model was developed within the traditional framework which can decompose food demand analytically into two components -- nutritional and nonnutritional components. Further, the nonnutritional component was analyzed in terms of effects of household characteristics in order to obtain some policy implications for nutritional education. The most important contribution of this study is to provide a framework to integrate more realistically nutritional and nonnutritional factors into traditional demand functions (which depend only on economic factors). The approach suggested is very simple but more realistic.

Objectives and Hypotheses

The general objective of this study was to develop a framework for explaining food purchase behavior that accounts for nutritional and nonnutritional considerations. The following specific objectives were: (a) to develop a method for measuring the nutritional and nonnutritional components of the demand for food; (b) to compare the nonnutritional demand structure of food products for different consumer groups; (c) to

analyze further the effects of household characteristics, such as income, region and urbanization, on the nonnutritional component of the demand for food.

The empirical analysis included 42 red meat, poultry, and fish products consumed in the United States. Three hypotheses were developed and tested in conjunction with the above objectives: (a) within the limitations imposed by economic factors, nutritional inefficiency exists in consumers' food purchase behavior; (b) the nutritional and the nonnutritional factors associated with food consumption are competitive; and (c) importance of nonnutritional factors increases with respect to total or residual food expenditure.

Procedure and Results

To accomplish the three specific objectives, food purchase behavior was considered in a broad context of human behavior rather than economic behavior alone as postulated by traditional demand theory or the new theory of consumer behavior proposed by Lancaster (1966). The consumer is assumed to maximize utility, $u = u(q/e, H^b, H^s)$ subject to a budget constraint, $p'q = m_f$ = food expenditure. This behavior yields demand functions of the form $q = q(e, H^b, H^s)$. Since nutritional or biogenic factors and the food composition matrix B (consumption technology matrix) can be measured objectively and quantitatively, the nutritional component, $q^{(1)}$ is assumed to be a deterministic and additive component of food demand. That is,

$$q = q^{(1)}(e^{(1)}, H^b, B) + q^{(2)}(e^{(2)}, H^s). \qquad (7\text{-}1)$$

where $q^{(1)}$ and $q^{(2)}$ are the nutritional and nonnutritional components of food demand, respectively, $e^{(1)} = p'q^{(1)}$, $e^{(2)} = p'q^{(2)}$, and

$e^{(1)} + e^{(2)} = m_f = p'q$. In general, $q^{(1)}$ can be any commodity vector such that $p'q^{(1)} < m_f$ and $Bq^{(1)} = Bq$. This study treats $q^{(1)}$ as the least cost food vector that achieves $z = Bq$ amount of nutrients. The non-nutritional compount $q^{(2)}$ is computed by the difference $q-q^{(1)}$ or $e-e^{(1)}$ in expenditure terms. For simplicity, the analysis is carried out in terms of expenditures.

The first objective is achieved by estimating the demand for food i, as $\hat{q}_i = q_i^{(1)} + \hat{q}_i^{(2)}$ (7-2)

where the nutritional component $q^{(1)}$ is determined by the least cost diet and the nonnutritional component $q_i^{(2)}$ is estimated by a linear expenditure system model as $\hat{q}_i^{(2)} = \frac{\hat{\beta}_i}{p_i}(m_f - p'q^{(1)}), \sum_{i=1}^{42} \hat{\beta} = 1$ (7-3)

for 12 region and urbanization consumer groups and by the regression model as $\hat{q}_i^{(2)} = \hat{\mu} + \sum_{j=1}^{k_i} \hat{\beta}_{ij} H_{ij}^s \quad i = 1, 2, \ldots, 42$ (7-4)

for the United States as a whole (k_i is the number of household characteristics relevant to food i). This study considered only one quantitative variable $m_f^{(2)}$ and two qualitative variables -- region and urbanization.

The second objective was achieved by computing β-coefficients of model (7-3) and expenditure elasticities η_{im} for 12 region-urbanization groups and their aggregates.

The third objective was achieved by means of regression model (7-4).

The three hypotheses were supported by the empirical results. The first hypothesis that the nutritional inefficiency exists in consumers' food purchase behavior was supported by the fact that each of 104 observations showed positive discretionary expenditures, $m_f^{(2)}$. The second hypothesis that the nutritional and nonnutritional factors

associated with food consumption are competitive was supported by the finding that the economically more (less) nutritious foods were generally underconsumed (over consumed). Finally, the third hypothesis that the influence of nonnutritional factors increases with increasing total (or discretionary) expenditure was supported by the finding that the sign of the coefficient of total (and discretionary) expenditure was generally positive (negative) for economically less (more) nutritious foods.

Limitations of the Study

The linear expenditure system used in this study is derived from an additive utility function. Hence this system is more suited to broad complementary categories of commodities and is less appropriate for finely divided substitute goods such as the meat products considered in this study. Also, the linear expenditure system used in this study places high emphasis on income or expenditure responses and, as such, it does not in the normal sense of the word measure responses of the nonnutritional component to price changes. Engel curves derived from the linear expenditure system are linear which is likely to be inconsistent with the true situation where the range of income or expenditure variation is wide. One may take little comfort in the fact that per capita food expenditures used in the present study did not have a wide range of variation.

Many important social variables discussed in Chapter IV could not be included as determinants of the nonnutritional component because data on these characteristics of households were not available and highly aggregated data in the form of region and urbanization were used.

Additivity of the nutritional and nonnutritional components of demand for food may be questionable as there may be an interaction between these two components. The definition of the nutritional component is very restrictive in the sense that it is computed purely on the basis of physiological needs for nutrients. However, the model developed is general enough to handle: (a) any number of nutrients, the only restriction being that the number of nutrients must be less than the number of foods analyzed and (b) other possible physiological needs such as bulk. These considerations would impose additional constraints in the computation of the least-cost diet. For example, if other physiological needs dictate a minimum quantity q_i° of the i^{th} food and a certain proportional use of two foods, say, $\frac{q_r}{q_k} = \alpha$ for the r^{th} and s^{th} foods, these requirements can be incorporated as additional constraints: $q_i \geq q_i^{\circ}$ for food i and $q_r - \alpha q_k = 0$ for foods q_r and q_k. Finally, since meat is the main food in the United States, results of the study show the predominance of overconsumption in the sense that a majority of the 42 food products proved to be normal foods and only a few proved to be inferior foods. The study should be extended to include other food products to obtain more realistic results with regard to overall food purchases.

Recommendations for Further Research

Three directions in which the present study might be extended include (a) empirical analysis to other food items; (b) determine the extent to which lack of knowledge of nutrient values by consumer may have contributed to the difference between the value of food expenditures and the value of the minimum cost diet; and (c) identify household

characteristics directly, rather than relying on indirect features of region and residence, and estimate their effects on the nonnutrition component of the demand for food.

Productivity of any individual depends on his total mental and physical health or well-being which is a function of emotional and nutritional status. Emotional status can be measured by the scores on the Brief Psychiatric Rating Scale (BPRS) and nutritional status can be measured by the nutritional intake vector $z = Bq$. If y is the BPRS vector (normally it has 18 variables such as somatic concern, anxiety, emotional withdrawal, conceptual disorganization, guilt feelings, etc.), the total well-being vector $x = (y'z')'$ may be subjected to appropriate statistical analysis. If necessary, dimensions of y and z can be reduced by taking a few of their principal components.

The total well-being vector (x) may be subjected to the principal component analysis to describe the differences between individuals in a heterogeneous sample in terms of a relatively few composite or compound variables, and to factor analysis to understand the latent structure and relationships among the psychological and nutritional variables. Since factor analysis is a statistical method used to explain the relationships among numerous correlated variables in terms of a relatively few underlying variates, it can be used to develop elaborate theories of personalities. Since factors are conceived as primary dimensions of individual differences, care should be exercised to obtain a good factor solution (transformation) in order to establish the three desirable properties of parsimony, orthogonality or at least relative independence, and conceptual meaningfulness of the factor solution.

Canonical correlation analysis is a method that can be used to find optimal linear combinations of psychological and nutritional variables. Discriminant and classification procedures of multivariate statistical analysis can be used to classify an individual into one of several consumer populations with different nutritional characteristics. Multivariate tests of hypotheses, Hotelling's T^2 to test $\mu_x = \mu_o$, can be used to determine whether a particular consumer community has a given level of well-being (emotional and/or nutritional).

Thus far, psychiatrists have analyzed only y and have ignored z, and economists have analyzed z and ignored y. Each procedure is a highly partial analysis and, therefore, is not adequate for an analysis of total well-being. The approach suggested here integrates both sets of factors into one to make the analysis more accurate and complete.

This suggested approach is generally relevant for a cross-section sample of individuals. That is, the data are $x_\alpha = (y'_\alpha, z'_\alpha)'$, where y_α is from psychiatric records and $z_\alpha = Bq_\alpha$ is from food consumption data. To make the analysis more accurate, x_α should be based on psychiatric and nutritional histories of the individual α. This approach would require time series data on both y_α and q_α. So y_α can be replaced by $\hat{y}_\alpha = \frac{1}{T} \sum_{t=1}^{T} y_{\alpha t}$, and z_α by $\hat{z}_\alpha = B\hat{q}_\alpha$ where $\hat{q}_\alpha$ is an estimate of q_α based on the time series sample $q_{\alpha t}$ $t = 1, 2, \ldots, T$. In particular $\hat{q}_\alpha = W_\alpha \hat{\beta}_\alpha$ where W_α is the matrix of observations on independent variables -- prices, incomes, and household characteristics, and β_α is the matrix of estimated regression coefficients for the α^{th} individual. Since the disturbances of demand relations of different food products are likely to be correlated and/or different food products are likely to have different sets of independent variables,

Zellner's (1962) method of estimating all the demand equations simultaneously with generalized least squares may be used to obtain $\hat{q}_\alpha = W_\alpha \hat{\beta}_\alpha$ $\alpha = 1, 2, \ldots, n$. Then $x_\alpha = (y'_\alpha, z'_\alpha)'$ $\alpha = 1, e, \ldots, n$ is subjected to statistical analysis as suggested above.

The conditional mean of psychological variables, $E(y/z)$, is obtained from the regression of y on $z = Bq$ where $q(p, m_f, H)$. Hence y can be regressed on prices, income, and household characteristics to determine the influence of economic and social variables on the psychological variables.

Recognizing the interdependence among (1) psychological well-being (2) nutritional well-being, and (3) earning capacity of an individual, one may analyze human well-being within the framework of simultaneous equations model with psychological variables y, nutritional variables z, (or a few of their principal components) and income as jointly dependent variables and all other household characteristics reflecting family size, sex, social class, food beliefs, mother's education and employment status, mass-media influence and possibly lagged endogeneous variables as predetermined variables. The three-stage Least Squared Method of estimation may be used to estimate the structure of human well-being.

Finally, there is a great need to incorporate nutrition as an element of human capital into models of economic growth and development because the concept of human capital is now well integrated into the body of economic theory and a significant amount of empirical evidence about its effect on labor productivity and earnings is available in econometric literature.

A P P E N D I X "A"

Derivations of Elasticities

APPENDIX "A"

Derivations of Elasticities

Our model is $q_i = q_i^{(1)} + q_i^{(2)} = q_i^{(1)}\ (p,B,z) + \frac{\beta_i}{p_i}\ (m_f - p'q^{(1)})$

(1) Expenditure elasticities:

$$\frac{\partial q_i}{\partial m_f} = \frac{\beta_i}{p_i} \text{ and } \eta_{im} = \frac{\partial q_i}{\partial m_f}\ \frac{m_f}{q_i} = \frac{\beta_i}{p_i}\ \frac{m_f}{q_i} = \frac{\beta_i}{\frac{p_i q_i}{m_f}} = \frac{\beta_i}{w_i}$$

Therefore $\eta_{im} = \Delta_\beta^{-1}\ \beta$. Hence the result (5-12) follows.

(2) Own-price elasticities:

$$\frac{\partial q_i}{\partial p_i} = \frac{\partial q_i^{(1)}}{\partial p_i} + \frac{\beta_i}{p_i}\ \{-p'\ \frac{\partial q^{(1)}}{\partial p_i} - q_i^{(1)}\}\ - \frac{\beta_i}{p_i^2}\ (m_f - p'q^{(1)}).$$

$$\eta_{ii} = \frac{\partial q_i}{\partial p_i}\ \frac{p_i}{q_i} = \frac{\partial q_i^{(1)}}{\partial p_i}\ \frac{p_i}{q_i} - \frac{\beta_i}{p_i}\ \frac{p_i}{q_i}\ \{\sum_{K\neq i} p_k\ \frac{q_k^{(1)}}{p_i} + \frac{q_i^{(1)}}{p_i}\ p_i$$

$$+ q_i^{(1)}\} - \frac{1}{p_i}\ (q_i - q_i^{(1)})\ \cdot\ \frac{p_i}{q_i}$$

$$= (1-\beta_i)\ \frac{\partial q_i^{(1)}}{\partial p_i}\ \frac{p_i}{q_i} + (1-\beta_i)\ \frac{q_i^{(1)}}{q_i} - 1 - \frac{\beta_i}{q_i}\ (\sum_{K\neq i} p_k q_k^{(1)}\ \frac{\partial q_k^{(1)}}{\partial p_i}$$

$$\frac{p_i}{q_k^{(1)}}\ )$$

$$= -1 + (1-\beta_i) \frac{\partial q_i^{(1)}}{\partial p_i} \frac{p_i}{q_i^{(1)}} \cdot \frac{q_i^{(1)}}{q_i} + (1-\beta_i) \frac{q_i^{(1)}}{q_i} - \frac{\beta_i}{p_i q_i}$$

$$\left(\sum_{\kappa \neq i}^{\eta} p_k q_k^{(1)} \frac{\partial q_k^{(1)}}{\partial p_i} \frac{p_i}{q_k^{(1)}} \right)$$

$$= -1 + \frac{q_i^{(1)}}{q_i} (1-\beta_i) (1+\eta_{ij}^{(1)}) - \frac{\beta_i}{e_i} \left(\sum_{\kappa \neq i} e_k^{(1)} \eta_{ki}^{(1)} \right) \quad i = 1,2,\ldots,n$$

Hence the result (5-13) follows

(3) Cross-price elasticities

$$\frac{\partial q_i}{\partial p_j} = \frac{\partial q_i^{(1)}}{\partial p_j} + \frac{\beta_i}{p_i} \left(-p' \frac{\partial q^{(1)}}{\partial p_j} - q_j^{(1)} \right)$$

$$\eta_{ij} = \frac{\partial q_i}{\partial p_j} \frac{p_j}{q_i} = - \frac{\beta_i p_j}{p_i q_i} q_j^{(1)} - \frac{\beta_i p_j}{p_i q_i} \left(\sum_{\kappa = i}^{\eta} p_k \frac{\partial q_k^{(1)}}{\partial p_j} + p_i \frac{\partial q_i^{(1)}}{\partial p_j} \right)$$

$$+ \frac{\partial q_i^{(1)}}{\partial p_j} \frac{p_j}{q_i}$$

$$= -\beta_i \frac{p_j q_j^{(1)}}{p_i q_i} + (1-\beta_i) \frac{\partial q_i^{(1)}}{\partial p_j} \frac{p_j}{q_i} - \frac{\beta_i}{e_i} \left(\sum_{\kappa \neq i}^{\eta} p_k q_k^{(1)} \frac{\partial q_e}{\partial p_j} \frac{p_j}{q_k^{(1)}} \right)$$

$$= - \frac{\beta_i e_j^{(1)}}{e_i} + (1-\beta_i) \eta_{ij}^{(1)} - \frac{\beta_i}{ei} \left(\sum_{\kappa \neq i}^{\eta} e_k^{(1)} \eta_{kj}^{(1)} \right)$$

Hence the result (5-15)

(4) Slutsky substitution effect:

$$\frac{\partial q_i}{\partial p_i} = \frac{\partial q_i^{(1)}}{\partial p_i} + \frac{\beta_i}{p_i} \left(- q_i^{(1)} - p' \frac{\partial q^{(1)}}{\partial p_i} \right) - \frac{\beta_i}{p_i^2} (m_f - p' q^{(1)})$$

$$= \frac{\partial q_i^{(1)}}{\partial p_i} + \frac{\beta_i}{p_i} \left(- q_i^{(1)} - p' \frac{\partial q^{(1)}}{\partial p_i} \right) - \frac{\beta_i m_f^{(2)}}{p_i^2}$$

$$S_{ij} = \frac{\partial q_i}{\partial p_i} + q_i \frac{\partial q_i}{\partial m_f} = \frac{\partial q_i^{(1)}}{\partial p_i} + \frac{\beta_i}{p_i} (- q_i^{(1)} - \sum_{\kappa \neq i}^{\eta} p_k \frac{\partial q_k^{(1)}}{\partial p_i}$$

$$p_i \frac{\partial q_i^{(1)}}{\partial p_i}) - \frac{\beta_i m_f^{(2)}}{p_i^{(2)}} + \frac{\beta_i}{p_i} \{q_i^{(1)} + \frac{\beta_i}{p_i} m_f^{(2)}\}$$

$$S_{ij} = (i-\beta_i) \frac{\partial q_i^{(1)}}{\partial p_i} + \frac{\beta_i}{p_i^2} m_f^{(2)} (\beta_i - 1) - \frac{\beta_i}{p_i} (\sum_{\kappa \neq i}^{\eta} p_k \frac{\partial q_k^{(1)}}{\partial p_i})$$

which is equivalent to (5-17).

Now $$\frac{\partial q_i^{(1)}}{\partial p_j} = \frac{\partial q_i^{(1)}}{\partial p_j} + \frac{\beta_i}{p_i} (- q_j^{(1)} - \sum_{\kappa=1}^{\eta} p_k \frac{\partial q_k^{(1)}}{\partial p_j}) \quad i \neq j$$

$$= (1-\beta_i) \frac{\partial q_i^{(1)}}{\partial p_j} - \frac{\beta_i}{p_i} q_j^{(1)} - \frac{\beta_i}{p_i} (\sum_{\kappa \neq i}^{\eta} p_\kappa \frac{\partial q_i^{(1)}}{\partial p_j})$$

$$S_{ij} = \frac{\partial q_i}{\partial p_j} + q_j \frac{\partial q_i}{\partial m_f} = (1-\beta_i) \frac{\partial q_i^{(1)}}{\partial p_j} - \frac{\beta_i}{p_i} q_j^{(1)} - \frac{\beta_i}{p_i} (\sum_{\kappa \neq i}^{\eta} p_k \frac{\partial q_k^{(1)}}{\partial p_j})$$

$$+ \frac{\beta_i}{p_i} (q_j^{(1)} + \frac{\beta_j}{p_j} m_f^{(2)})$$

$$= (1-\beta_i) \frac{\partial q_i^{(1)}}{\partial p_i} + \frac{\beta_i \beta_j}{p_i p_j} m_f^{(2)} - \frac{\beta_i}{p_i} (\sum_{\kappa \neq i}^{\eta} p_k \frac{\partial q_k^{(1)}}{\partial p_j}) \text{ for } i \neq j$$

which is equivalent to (5-21).

A P P E N D I X "B"

Region and Urbanization Classifications

APPENDIX "B"

Regions and Urbanizations Classification

Definitions of Four Regions:

Northeast

Connecticut	New Hampshire	Pennsylvania
Maine	New Jersey	Rhode Island
Massachusetts	New York	Vermont

South

Alabama	Georgia	Oklahoma
Arkansas	Kentucky	South Carolina
Delaware	Louisiana	Tennessee
District of Columbia	Mississippi	Virginia
Florida	North Carolina	West Virginia

North Central

Illinois	Michigan	North Dakota
Indiana	Minnesota	Ohio
Iowa	Missouri	South Dakota
Kansas	Nebraska	Wisconsin

West

Arizona	Montana	Utah
California	Nevada	Washington
Colorado	New Mexico	Wyoming
Idaho	Oregon	

Alaska and Hawaii are not included in this study.

Definitions of Three Urbanizations:

(1) Urban Households: Households in places with at least 2,500 inhabitants and in closely settled fringe areas surrounding cities of 50,000 or more inhabitants.

(2) Rural Nonfarm Households: The farm households outside of the urban places without a farm operator.

(3) Rural Farm Households: The farm households outside of urban places with a farm operator.

A P P E N D I X "C"

Tables C-1 to C-13

Table C-1. Estimates of β-vector, by residential (urbanization) groups, United States

Food code	U.S. (104)[a]	Urban (48)[a]	Rural nonfarm (28)[a]	Rural farm (28)[a]
		Beef		
1	10.2*	10.7*	7.2*	13.5*
2	3.9*	4.2*	3.0*	4.2*
3	5.0*	5.*	3.5*	8.2*
4	8.4*	10.9*	4.0*	3.8*
5	7.1*	6.8*	6.3*	10.1*
6	0.7*	0.6*	0.6*	1.2*
7	1.1*	1.2*	0.9*	1.2*
8	2.3*	2.6*	1.6*	2.3*
9	(-0.3)	(-0.3)	(-0.5)	0.1*
10	0.8*	1.0*	0.4*	0.3*
11	13.9*	11.1*	16.0*	24.9*
12	0.7*	0.4*	0.8*	1.6*
13	0.2*	0.2*	0.0	0.5*
		Pork		
14	6.4*	7.0*	5.1*	5.7*
15	0.1	0.4*	(-0.1)	(-1.2)
16	0.9*	1.1*	0.5*	0.6*
17	2.4*	2.0*	2.9*	4.2*
18	1.0	1.0	0.1	2.7*
19	9.2*	9.4*	8.3*	10.4*
20	8.6*	8.3*	8.3*	10.8*
21	(-2.7*)	(-2.3*)	(-1.8)	(-7.0*)
22	0.9*	1.0*	0.7	1.0
23	0.9*	0.9*	0.9*	0.8*
		Veal		
24	1.0*	1.3*	0.4*	0.3*
25	0.1*	0.1*	0.01*	0.01*
26	0.05*	0.03*	0.0	0.01*
		Lamb		
27	0.8*	1.1*	0.2*	0.1*
28	0.3*	0.3*	0.2*	0.1*
29	(-1.2*)	(-1.6*)	(-0.7)	0.0
		Variety meats		
30	(-13.8*)	(-15.4*)	(-8.0)	(-16.9*)
31	(-2.7*)	(-2.6*)	(-1.8)	(-5.4*)

Table C-1 (Continued)

Food code	U.S. (104)[a]	Urban (48)[a]	Rural nonfarm (28)[a]	Rural farm (28)[a]
		Lunch meats		
32	5.4*	5.0*	6.0*	6.1*
33	0.6*	0.6*	0.4	0.7*
34	10.4*	10.7*	9.8*	9.8*
		Poultry		
35	15.2*	14.9*	17.6*	12.2
36	(-3.5*)	(-4.2*)	(-0.5)	(-5.4*)
37	0.05*	0.04*	0.1	0.1*
		Fish		
38	3.7*	3.5*	3.7*	4.7*
39	(-0.8)	(-0.4)	0.6*	(-5.7)
40	(-0.7*)	(-0.7)	(-0.5*)	(-0.9)
41	1.9*	2.3*	1.5*	0.9
42	1.5*	1.7*	1.3*	0.5*
		All meat		
$\Sigma\beta_i$	100.0	99.9	99.4	100.8

[a]Number of observations.

*Significant at the 5 percent level.

Table C-2. Estimates of β-vector, by residential (urbanization) groups, northeastern region

Food code	Region (22)[a]	Urban (12)[a]	Rural nonfarm (5)[a]	Rural farm (5)[a]
		Beef		
1	7.6*	8.1*	6.9*	6.1*
2	4.5*	5.2*	3.7*	1.3
3	3.8*	3.8*	3.5*	5.1*
4	13.8*	17.2*	7.1*	6.8
5	6.2*	5.4*	6.7*	11.2*
6	0.6*	0.6	0.7	0.8
7	2.0*	2.5*	0.6*	0.9
8	1.6*	1.8*	1.2*	1.3
9	0.1	0.7*	(-1.4)	0.3
10	0.7*	0.8*	0.6*	0.2
11	10.5*	7.2*	14.0*	27.6*
12	0.4	0.4*	0.4	0.6
13	0.1	0.2	(-0.5)	1.1
		Pork		
14	6.6*	7.6*	4.8*	3.7
15	0.1	0.4*	(-0.5)	0.2
16	1.0*	1.1*	0.8*	0.5
17	2.3*	2.6*	1.3*	3.2*
18	0.3	0.2	0.4*	1.2*
19	10.8*	11.5*	9.4*	9.6*
20	5.4*	4.9	6.4*	7.2*
21	(-1.5*)	(-1.5*)	(-1.3)	(-2.3)
22	0.8*	0.9*	0.7*	0.6*
23	0.7*	0.6*	0.9*	0.8*
		Veal		
24	2.5*	3.3*	1.0*	0.7
25	0.1*	0.2*	0.0	0.0
26	0.1*	0.1*	0.0	0.0
		Lamb		
27	1.6*	2.3*	0.4*	0.0
28	0.4*	0.5*	0.2	0.0
29	(-0.6)	(-1.0)	0.0	0.0
		Variety meats		
30	(-16.0*)	(-19.7*)	(-5.7*)	(-18.7*)
31	(-1.0)	(-0.2)	(-3.2)	(-5.1)

Table C-2 (Continued)

Food code	Region (22)[a]	Rural (12)[a]	Rural nonfarm (5)[a]	Rural farm (28)[a]
		Lunch meats		
32	5.4*	4.27	7.6*	8.4*
33	0.5*	0.5*	0.5	0.5*
34	11.2*	11.1*	12.3*	8.8*
		Poultry		
35	17.0*	17.9*	14.6*	17.1*
36	(-6.1*)	(-8.5*)	(-0.3)	(-4.2)
37	0.03*	0.1	0.0	0.0
		Fish		
38	4.2*	5.2*	1.9*	4.0*
39	(-1.5)	(-2.6)	0.6*	0.7*
40	(-0.7*)	(-0.9*)	(-0.2)	(-0.6)
41	2.5*	3.0*	2.1*	(-0.4)
42	2.0*	2.3*	1.8	0.7
		All meat		
$\Sigma\beta_i$	100.0	100.0	100.0	100.0

[a]Number of observations.

*Significant at the 5 percent level.

Table C-3. Estimates of β-vector, by residential (urbanization) groups, north central region

Food code	Region (30)[a]	Urban (12)[a]	Rural nonfarm (9)[a]	Rural farm (9)[a]
		Beef		
1	10.7*	10.6*	7.5*	14.9*
2	3.1*	2.8*	3.2*	4.4*
3	5.3*	4.8*	4.3*	8.5*
4	4.8*	5.9*	3.3*	1.8*
5	8.3*	7.7*	6.9*	13.0*
6	0.7*	0.7*	0.6*	1.2*
7	0.6*	0.43*	0.8*	1.1
8	3.3*	3.7*	2.2	2.8*
9	(-1.7)	(-2.1)	(-1.4)	0.0
10	0.8*	0.9*	0.7*	0.5*
11	19.0*	14.6*	22.4*	35.3*
12	0.7*	0.3	1.3*	2.1
13	0.2*	0.2*	0.9*	0.3
		Pork		
14	6.3*	6.6*	5.3*	6.0*
15	(-0.4)	0.2*	(-0.3)	(-3.67)
16	1.6*	1.9*	0.8*	0.8*
17	1.8*	1.2	2.9*	2.8*
18	2.3*	2.2*	1.8*	3.3*
19	9.3*	8.3*	10.5*	12.3*
20	7.5*	9.3*	1.5	6.5
21	(-2.8*)	(-1.9*)	(-2.7*)	(-7.2*)
22	0.8*	1.2*	0.1	0.4
23	1.1*	1.2*	0.9*	0.9*
		Veal		
24	0.4*	0.6*	0.1	0.0
25	0.1*	0.1*	0.1	0.01*
26	0.1*	0.1*	0.0	0.0
		Lamb		
27	0.1*	0.1*	0.0	0.1
28	0.1*	0.1*	0.1	0.0
29	(-1.4)	(-2.1)	0.1	0.0
		Variety meats		
30	(-12.5*)	(-11.9*)	(-12.5*)	(-15.2*)
31	(-4.2*)	(-5.0*)	(-2.4)	(-3.0)

Table C-3 (Continued)

Food code	Region (30)[a]	Urban (12)[a]	Rural nonfarm (9)[a]	Rural farm (9)[a]
		Lunch meats		
32	6.10*	5.7*	6.9*	6.9*
33	0.1	0.3	(-1.2)	0.5*
34	12.9*	13.1*	12.9*	12.1*
		Poultry		
35	16.8*	18.7*	16.5*	8.5
36	(-3.6*)	(-3.1)	(-2.3)	(-7.2)
37	0.1	0.0	0.2	0.1*
		Fish		
38	1.8*	1.2*	2.6*	3.5*
39	(-1.7)	0.1	1.1*	(-13.2)
40	(-0.4*)	(-0.4*)	(-0.2)	(-0.9)
41	1.4*	1.4*	1.3*	1.2*
42	0.6*	0.6*	0.8*	0.3
		All meat		
$\Sigma\beta_i$	100.1	100.3	98.6	100.9

[a]Number of observations.

*Significant at the 5 percent level.

Table C-4. Estimates of β-vector, by residential (urbanization) groups, southern region

Food code	Region (30)[a]	Urban (12)[a]	Rural nonfarm (9)[a]	Rural farm (9)[a]
		Beef		
1	10.4*	12.9*	7.1*	12.6*
2	3.8*	6.13*	2.3*	1.0
3	5.0*	5.8*	3.0*	8.7*
4	6.0*	9.9*	2.6*	4.0*
5	7.1	8.7*	5.5*	7.0*
6	0.5*	0.6*	0.4	0.2
7	1.0*	1.3*	0.9*	0.5*
8	1.6*	1.6	1.3	2.6*
9	0.6*	0.7*	0.5*	0.4
10	0.6*	1.2*	0.2*	0.1*
11	14.2*	13.9*	13.5*	17.5*
12	0.8*	0.5*	0.7*	1.8
13	0.3*	0.5	0.2*	0.4
		Pork		
14	6.8*	8.0*	5.3*	7.4*
15	0.4*	0.3	0.3*	1.2
16	0.2*	0.2	0.2*	0.3
17	4.2*	3.3*	3.9*	7.9*
18	(-0.8)	(-1.6)	(-1.4)	3.6*
19	10.4*	13.4*	6.8*	11.9*
20	15.7*	16.4*	13.6*	20.1*
21	(-5.7*)	(-7.3*)	(-1.4)	(-14.8)
22	1.4*	1.5*	1.0*	1.8
23	0.9*	0.6*	1.1*	0.6*
		Veal		
24	0.4*	0.7*	0.2*	0.3
25	0.0	0.0	0.0	0.0
26	0.02*	0.01*	0.0	0.0
		Lamb		
27	0.2*	0.3*	0.2	0.0
28	0.2*	0.1*	0.2	0.2
29	(-0.6)	0.0	(-1.4)	0.0
		Variety meats		
30	(-13.0*)	(-17.3*)	(-7.5)	(-16.3*)
31	(-3.7*)	(-4.3)	0.1*	(-14.1*)

Table C-4 (Continued)

Food code	Region (30)[a]	Urban (12)[a]	Rural nonfarm (9)[a]	Rural farm (9)[a]
		Lunch meats		
32	4.8*	5.1*	4.7*	4.4*
33	1.3*	1.4*	1.3*	1.2*
34	7.8*	9.1*	6.3*	8.1*
		Poultry		
35	9.2	(-2.7)	20.3*	12.9
36	(-2.0)	(-4.1)	0.2*	(-2.3)
37	0.01*	0.1*	0.0	0.0
		Fish		
38	6.8*	6.6*	6.0*	9.8*
39	0.3	0.7*	0.4*	(-1.4)
40	(-0.9*)	(-0.9*)	(-1.0*)	(-0.8)
41	1.3*	1.75*	1.0*	0.7*
42	2.0*	3.0*	1.3*	0.7*
		All meat		
$\Sigma\beta_i$	99.7	98.8	99.9	100.2

[a]Number of observations.

*Significant at the 5 percent level.

Table C-5. Estimates of β-vector, by residential (urbanization) groups, western region

Food code	Region (22)[a]	Urban (12)[a]	Rural nonfarm (5)[a]	Rural farm (5)[a]
Beef				
1	12.9*	12.6*	8.6*	18.2*
2	4.7*	4.0*	3.7*	10.3*
3	6.1*	6.1*	2.1*	9.2
4	10.2*	11.8*	3.2	5.4
5	5.9*	5.6*	7.8*	6.5
6	0.9*	0.6*	1.4	2.9*
7	1.0*	0.8*	2.0	0.8
8	2.5*	2.6*	2.1*	1.8
9	0.6*	0.8*	0.4	0.1
10	1.2*	1.4*	0.5	0.3
11	8.8	8.0*	14.8*	8.4
12	0.7*	0.6*	1.5	1.0
13	0.3*	0.2*	0.8	0.7
Pork				
14	5.9*	6.3*	4.6*	4.4
15	0.5*	0.6*	0.1	0.1
16	0.4*	0.5*	0.2	0.3
17	1.8*	1.4*	2.6	3.6
18	1.8*	1.8*	1.2*	1.7
19	5.3*	5.5*	3.8	5.0
20	6.3*	4.9	11.3*	11.5
21	(-0.5)	(-0.3)	(-1.6)	(-0.9)
22	0.7*	0.6*	0.5	1.6*
23	0.7*	0.6*	0.7*	0.9
Veal				
24	0.2*	0.3*	0.0	0.3
25	0.0	0.0	0.0	0.0
26	0.01*	0.0	0.0	0.0
Lamb				
27	1.4*	1.7*	0.0	0.2
28	0.5*	0.5*	0.3	0.2
29	(-2.2)	(-2.6)	(-2.4)	0.0
Variety meats				
30	(-13.9*)	(-14.2*)	(-3.3)	(-19.8)
31	(-0.9)	(-0.7)	(-4.9)	0.1

Table C-5 (Continued)

Food code	Region (22)[a]	Urban (12)[a]	Rural nonfarm (5)[a]	Rural farm (5)[a]
		Lunch meats		
32	4.7*	4.8*	4.0*	4.4
33	0.8*	0.7*	1.3*	0.8
34	7.5*	7.4*	7.8*	7.6
		Poultry		
35	17.3*	17.6*	17.7*	15.3
36	(-1.3)	(-0.6)	0.9	(-6.6)
37	0.1	0.01*	0.0	0.5
		Fish		
38	2.7*	2.9*	2.2*	2.0
39	0.5*	0.6*	0.3	0.2
40	(-0.7*)	(-0.7*)	0.2	(-1.3)
41	3.0*	3.3*	2.7*	1.7
42	1.7*	2.0*	0.9	0.6*
		All meat		
$\Sigma\beta_i$	100.1	100.0	100.0	100.0

[a]Number of observations.

*Significant at the 5 percent level.

Table C-6. Percentage of budget shares $(100\ w_i)$[a] and expenditure elasticities (η_{im})[b], by residential (urbanization) groups, United States

Food code	Total		Urban		Rural nonfarm		Rural farm	
	$100\ w_i$	η_{im}	$100\ w_i$	η_{im}	$100\ w_i$	η_{im}	$100\ w_i$	η_{im}
				Beef				
1	6.5	1.57*	6.5	1.65*	6.2	1.16*	7.4	1.82*
2	4.3	0.91*	4.6	0.91*	3.9	0.77*	4.0	1.05*
3	4.5	1.11*	4.4	1.14*	4.3	0.81*	5.9	1.39*
4	5.6	1.50*	6.4	1.70*	3.9	1.03*	2.6	1.46*
5	5.5	1.29*	5.5	1.24*	5.7	1.11*	5.9	1.71*
6	1.1	0.64*	1.0	0.60*	0.9	0.67	1.2	1.00*
7	1.7	0.65*	1.9	0.63*	1.5	0.60*	1.3	0.69*
8	2.7	0.85*	2.8	0.93*	2.3	0.70*	2.4	0.96*
9	0.7	(-0.43)	0.8	(-0.38)	0.7	(-0.83)	0.3	0.33
10	0.8	1.00*	0.9	1.11*	0.6	0.67*	0.3	1.00*
11	7.2	1.93*	6.3	1.76*	9.5	1.68*	10.5	2.37*
12	1.0	0.70*	0.7	0.57*	1.1	0.73*	1.9	0.84
13	0.4	1.50*	0.4	0.50*	0.6	0.00	0.6	0.83*
				Pork				
14	4.7	1.36*	4.7	1.49*	4.5	1.13*	4.2	1.36*
15	0.7	0.14	0.6	0.67*	0.7	(-0.14)	1.1	(-1.09)
16	1.2	0.75*	1.3	0.85*	0.9	0.56*	0.7	0.86*
17	2.1	1.14*	2.0	1.00*	2.6	1.12*	2.7	1.56*
18	1.9	0.53	1.9	0.53	1.5	0.07	2.6	1.04*
19	6.2	1.48*	6.0	1.57*	6.7	1.24*	6.7	1.55*
20	5.3	1.62	4.9	1.69*	6.3	1.32*	6.3	1.71*
21	0.3	(-0.99*)	0.2	(-11.50*)	0.5	(-3.60*)	0.8	(-8.75*)
22	1.3	0.69*	1.3	0.77*	1.1	0.64	1.5	0.67
23	1.3	0.69	1.3	0.69*	1.5	0.60*	1.4	0.57*
				Veal				
24	1.3	0.77*	1.5	0.87*	0.7	0.57*	0.3	1.00*
25	0.2	0.50*	0.2	0.50*	0.1	0.10*	0.1	0.10*
26	0.1	0.50*	0.1	0.3*	0.0	0.00	0.1	0.10*

Table C-6 (Continued)

Food code	Total		Urban		Rural nonfarm		Rural farm	
	100 w_i	η_{im}	100 w_i	η_{im}	100 w_i	η_{im}	100 w_i	η_{im}
				Lamb				
27	0.18	1.00*	1.0	1.1*	0.3	0.67*	0.1	1.00*
28	0.6	0.50*	0.7	4.3*	0.3	0.67*	0.1	1.00*
29	0.1	(-12.00*)	0.1	(-16.00*)	0.00	$(-\infty)$	0.00	0.00
				Variety meats				
30	0.1	(-12.55*)	1.2	(-12.83*)	0.8	(-10.00*)	0.9	(-18.78*)
31	0.2	(-13.50*)	0.3	(-8.67*)	0.1	(-18.00)	0.2	(-27.00*)
				Lunch meats				
32	3.4	1.59*	3.4	1.47*	0.4	1.50*	3.2	1.91*
33	0.7	0.86*	0.7	0.86*	1.0	0.40	0.8	0.88*
34	5.5	1.89*	5.5	1.95*	5.8	1.69*	4.8	2.04*
				Poultry				
35	10.4	1.46*	10.4	1.43*	10.6	1.66*	9.8	1.24
36	1.0	(-3.5*)	1.0	(-4.2*)	0.8	(-0.63)	0.5	(-10.80*)
37	0.1	0.50*	0.1	0.40*	0.2	0.50	0.2	0.50*
				Fish				
38	3.3	1.12*	3.0	1.17*	3.8	0.97*	4.0	1.17*
39	0.7	(-1.14)	0.7	(-0.57)	0.8	0.75*	0.6	(-9.50)
40	0.5	(-1.40*)	0.4	(-1.75*)	0.7	(-0.71*)	0.8	(-1.13)
41	1.4	1.36*	1.5	1.53*	1.3	1.15*	0.8	1.13
42	1.6	0.94*	1.7	1.00*	1.4	0.93*	0.6	0.83*

[a] $w_i = p_i q_i / m_f$.

[b] $\eta_{im} = \beta_i / w_i$.

*The coefficients were significant at the 5 percent level.

Table C-7. Percentage of budget shares ($100\ w_i$)[a] and expenditure elasticities (η_{im})[b], by residential (urbanization) groups, northeastern region

Food code	Region $100\ w_i$	Region η_{im}	Urban $100\ w_i$	Urban η_{im}	Rural nonfarm $100\ w_i$	Rural nonfarm η_{im}	Rural farm $100\ w_i$	Rural farm η_{im}
Beef								
1	5.1	1.49*	4.8	1.69*	6.3	1.09*	4.9	1.24*
2	5.3	0.85*	5.5	0.95*	4.9	0.75*	2.0	0.65
3	3.9	0.97*	3.6	1.06*	5.2	0.67*	5.2	0.98*
4	8.2	1.68*	8.8	1.95*	6.0	1.18*	5.1	1.33
5	4.8	1.29*	4.4	1.23*	6.1	1.10*	8.1	1.39*
6	1.4	0.43*	1.4	0.43	1.1	0.64	1.1	0.73
7	2.8	0.71*	3.2	0.78*	1.4	0.43*	1.7	0.53
8	2.3	0.70*	2.4	0.75*	2.0	0.60*	2.2	0.59
9	0.7	0.14	0.8	0.87*	0.4	(-3.50)	0.4	0.75
10	1.0	0.7*	1.1	0.74*	0.8	0.75*	0.4	0.50
11	5.2	2.02*	4.1	1.76*	8.5	1.65*	12.6	2.19*
12	0.6	0.67	0.6	0.67*	0.8	0.50	2.3	0.26
13	0.4	0.25	0.3	0.67	0.8	(-0.63)	1.2	0.92
Pork								
14	4.5	1.47*	4.6	1.65*	4.3	1.12*	3.4	1.09
15	0.6	0.17	0.7	0.57*	0.4	(-1.25)	0.4	0.50
16	1.3	0.77*	1.3	0.85*	1.3	0.62*	0.9	0.56
17	1.9	1.21*	1.8	1.44*	1.5	0.87*	2.3	1.39*
18	1.3	0.23	1.5	0.13	0.7	0.57*	1.7	0.71*
19	6.3	1.71*	6.2	1.85*	7.1	1.32*	6.9	1.39*
20	3.4	1.59*	3.2	1.53	4.1	1.56*	4.1	1.76*
21	0.1	(-15.00*)	0.1	(-15.0*)	0.1	(-13.0)	0.2	(-11.5)
22	1.1	0.73*	1.1	0.82*	1.1	0.64*	0.9	0.67*
23	1.1	0.64*	1.0	0.6*	1.4	0.64*	1.3	0.61*
Veal								
24	2.6	0.96*	2.9	1.14*	1.5	0.67*	1.2	0.58
25	0.3	0.33*	0.3	0.67*	0.1	0.00	0.0	0.0
26	0.2	0.50*	0.2	0.50*	0.1	0.00	0.9	0.0

Table C-7 (Continued)

Food code	Region 100 w_i	Region η_{im}	Urban 100 w_i	Urban η_{im}	Rural nonfarm 100 w_i	Rural nonfarm η_{im}	Rural farm 100 w_i	Rural farm η_{im}
				Lamb				
27	1.7	0.94*	1.9	1.21*	0.9	0.44	0.1	0.0
28	1.0	0.40*	1.1	0.45*	0.7	0.29	0.0	0.0
29	0.2	(-3.00)	0.2	(-5.00)	0.1	0.0	0.0	0.0
				Variety meats				
30	1.1	(-14.55*)	1.3	(-15.15*)	0.7	(-8.14*)	1.1	(-17.00*)
31	0.4	(-2.50)	0.5	(-0.40)	0.1	(-32.0)	0.1	(-51.00)
				Lunch meats				
32	3.7	1.46*	3.4	1.26	4.6	1.65*	4.5	1.87*
33	0.6	0.83*	0.5	1.00*	0.6	0.83	0.5	1.00*
34	5.7	1.96*	5.4	2.06*	6.9	1.78*	4.9	1.80*
				Poultry				
35	10.1	1.68*	10.3	1.74	9.4	1.55*	9.3	1.84*
36	1.3	(-4.69*)	1.3	(-6.54*)	1.3	(-0.23)	0.8	(-5.25)
37	0.1	0.30*	0.1	1.00	0.1	0.00	0.0	0.0
				Fish				
38	3.1	1.35*	3.3	1.58*	2.1	0.91*	3.2	1.25*
39	0.6	(-2.50)	0.5	(-5.20)	0.9	0.67*	0.9	0.78*
40	0.4	(-1.75*)	0.4	(-2.25*)	0.6	(-0.33)	0.6	(-1.00)
41	1.8	1.38*	1.8	1.67*	1.6	1.31*	1.5	(-0.27)
42	2.0	1.00*	2.1	1.09*	1.9	0.95	0.9	0.78

[a] $w_i = p_i q_i / m_f$.

[b] $\eta_{im} = \beta_i / w_i$.

*The coefficients were significant at the 5 percent level.

Table C-8. Percentage of budget shares ($100\ w_i$)[a] and expenditure elasticities (η_{im})[b], by residential (urbanization) groups, north central region

Food code	Region $100\ w_i$	Region η_{im}	Urban $100\ w_i$	Urban η_{im}	Rural nonfarm $100\ w_i$	Rural nonfarm η_{im}	Rural farm $100\ w_i$	Rural farm η_{im}
				Beef				
1	6.8	1.57*	6.9	1.54*	5.8	1.29*	8.2	1.82*
2	4.0	0.78*	3.9	0.72*	3.6	0.89*	5.5	0.80*
3	5.1	1.04*	5.1	0.94*	4.7	0.91*	6.0	1.42*
4	3.8	1.26*	4.2	1.41*	3.2	1.03*	2.0	0.90*
5	6.2	1.34*	6.3	1.22*	5.6	1.23*	7.0	1.86*
6	1.0	0.70*	0.9	0.78*	0.9	0.67*	1.5	0.80*
7	1.1	0.55*	0.9	0.44*	1.4	0.57*	1.5	0.73
8	3.4	0.97*	3.6	1.03*	3.1	0.71	2.8	1.00*
9	0.4	(-4.25)	0.6	(-3.50)	0.2	(-7.00)	0.1	0.00
10	0.8	1.00*	0.8	1.12*	0.8	0.87*	0.6	0.83*
11	9.6	1.98*	8.5	1.72*	11.5	1.95*	13.0	2.71*
12	1.0	0.70*	0.8	0.37	1.4	0.93	1.9	1.10*
13	0.4	0.50*	0.4	0.50*	0.3	3.00*	0.5	0.60
				Pork				
14	4.8	1.31*	4.9	1.35*	4.6	1.15*	3.9	1.54*
15	0.6	(-0.67)	0.5	0.40*	1.0	(-0.3)	1.1	(-3.34)
16	1.8	0.89*	2.1	0.91*	1.2	0.67*	0.9	0.89*
17	2.1	0.86*	2.0	0.60	2.3	1.26*	1.8	1.56*
18	2.4	0.96*	2.4	0.92*	2.0	0.90*	2.7	1.22*
19	6.5	1.43*	6.3	1.32*	7.4	1.42*	6.1	2.02*
20	5.4	1.39*	5.2	1.79*	5.9	0.25	5.6	1.16
21	0.1	(-28.00*)	0.1	(-19.00*)	0.2	(-13.5*)	0.5	(-14.4*)
22	1.2	0.67*	1.4	0.86*	0.8	(0.12)	1.2	0.33
23	1.6	0.69*	1.6	0.75*	1.4	0.64*	1.3	0.69*
				Veal				
24	0.7	0.57*	0.9	0.67*	0.3	0.33	0.2	0.05*
25	0.2	0.50*	0.3	0.33*	0.1	1.00	0.1	0.0
26	0.1	1.00*	0.2	0.50*	0.4	0.00	0.1	0.0

Table C-8 (Continued)

Food code	Region		Urban		Rural nonfarm		Rural farm	
	100 w_i	im	100 w_i	im	100 w_i	im	100 w_i	im
				Lamb				
27	0.2	0.50*	0.3	0.33*	0.1	0.00	0.1	1.00
28	0.3	0.33*	0.4	0.25*	0.2	0.50	0.1	0.00
29	0.1	(-14.00)	0.2	(-10.5)	0.2	0.50	0.0	0.00
				Variety meats				
30	0.8	(-15.63*)	0.8	(-14.87*)	0.9	(-13.84*)	0.7	(-21.71*)
31	0.2	(-21.00*)	0.2	(-25.00*)	0.1	(-24.0)	0.2	(-15.00)
				Lunch meats				
32	3.6	1.69*	3.5	1.63*	4.2	1.64*)	3.4	2.03*
33	0.5	0.20	0.5	0.60	0.7	(-1.71)	0.6	0.83*
34	6.7	1.93*	6.9	1.90*	6.8	1.90*	5.3	2.28*
				Poultry				
35	9.4	1.79*	9.8	1.91*	9.2	1.79*	7.7	1.10
36	0.7	(-5.14*)	0.9	(-3.44)	0.4	(-5.75)	0.4	(-18.00)
37	0.1	1.00	0.1	0.00	0.3	0.67	0.3	0.33*
				Fish				
38	2.0	0.90*	1.8	0.67*	2.4	1.08*	2.7	1.30*
39	1.1	(-1.55)	1.1	0.09	1.3	0.85*	0.6	(-22.00)
40	0.6	0.67*	0.5	(-0.80*)	0.8	(-1.25)	0.7	(-1.29)
41	1.1	1.27*	1.1	1.27*	1.1	1.18*	0.8	1.5*
42	0.8	0.75*	0.8	0.75*	1.1	0.73*	0.5	0.60

[a] $w_i = p_i q_i / m_f$.

[b] $\eta_{im} = \beta_i / w_i$.

*The coefficients were significant at the 5 percent level.

Table C-9. Percentage of budget shares ($100\ w_i$)[a] and expenditure elasticities (η_{im})[b], by residential (urbanization) groups, southern region

Food code	Region		Urban		Rural nonfarm		Rural farm	
	$100\ w_i$	η_{im}	$100\ w_i$	η_{im}	$100\ w_i$	η_{im}	$100\ w_i$	η_{im}
Beef								
1	6.7	1.55*	6.9	1.87*	6.2	1.14*	6.2	2.03*
2	3.9	0.97*	4.5	1.36*	3.3	0.70*	2.1	0.48
3	4.2	1.19*	4.3	1.35*	3.6	0.83*	5.3	1.64*
4	4.1	1.46*	4.8	2.06*	3.1	0.84*	2.4	1.67*
5	5.4	1.31*	5.7	1.53*	5.3	1.04*	4.3	1.63*
6	0.7	0.71*	0.7	0.86*	0.6	0.67	0.4	0.50
7	1.3	0.77*	1.4	0.93*	1.4	0.64*	0.7	0.71*
8	2.1	0.76*	2.3	0.70	1.8	0.72	2.1	1.24*
9	0.8	0.75*	0.8	0.87*	1.0	0.50*	0.6	0.67
10	0.5	1.20*	0.7	1.71*	0.3	0.67*	0.1	1.00*
11	7.4	1.92*	6.9	2.01*	8.2	1.65*	7.7	2.27*
12	1.1	0.73*	0.8	0.62*	1.3	0.54*	1.8	1.00
13	0.6	0.50*	0.7	0.71	0.5	0.40*	0.7	0.57
Pork								
14	4.7	1.45*	4.9	1.63*	4.5	1.18*	5.0	1.48*
15	0.7	0.57*	0.6	0.50	0.6	0.50*	1.3	0.92
16	0.5	0.40*	0.6	0.33	0.4	0.50*	0.4	0.75
17	2.9	1.45*	2.4	1.37*	3.6	1.08*	3.8	2.08*
18	1.8	(-0.44)	1.8	(-0.89)	1.7	(-0.82)	2.7	1.33*
19	6.5	1.60*	6.5	2.06*	6.2	1.10*	7.9	1.51*
20	7.0	2.24*	6.5	2.52*	8.0	1.70*	7.7	2.61*
21	0.6	(-9.50*)	0.5	(-14.60*)	0.9	(-1.56)	1.6	(-9.25)
22	1.6	0.88*	1.5	1.00*	1.4	0.71*	1.9	0.95
23	1.2	0.75*	1.0	0.60*	1.5	0.73*	1.5	0.40
Veal								
24	0.8	0.50	1.0	0.70*	0.5	0.40*	0.2	1.50
25	0.1	0.00	0.1	0.00	0.1	0.00	0.1	0.00
26	0.1	0.20*	0.1	0.10*	0.1	0.00	0.2	0.00

Table C-9 (Continued)

Food code	Region		Urban		Rural nonfarm		Rural farm	
	100 w_i	η_{im}	100 w_i	η_{im}	100 w_i	η_{im}	100 w_i	η_{im}
Lamb								
27	0.4	0.50*	0.4	0.75*	0.3	0.67	0.1	0.00
28	0.4	0.50*	0.4	0.25*	0.4	0.50	0.1	2.00
29	0.0	(- ∞*)	0.1	0.00	0.0	-∞	0.0	0.00
Variety meats								
30	1.1	(-11.82*)	1.2	(-14.42*)	0.9	(-8.33*)	0.9	(-18.11*)
31	0.2	(-18.50*)	0.2	(-21.50)	0.3	0.33*	0.2	(-70.50*)
Lunch meats								
32	3.1	1.55*	3.0	1.70*	3.6	1.30*	2.7	1.63*
33	1.2	1.08*	0.8	1.75*	1.5	0.87*	1.1	1.09*
34	4.5	1.73*	4.6	1.98*	4.4	1.43*	4.3	1.88*
Poultry								
35	11.7	0.79	11.4	(-0.24)	12.5	1.62*	12.5	1.03
36	0.6	(-3.33)	0.7	(-5.86)	0.4	0.50*	0.6	(-4.33)
37	0.1	0.10*	0.1	1.00*	0.1	0.0	0.0	0.00
Fish								
38	5.1	1.33*	4.5	1.47*	6.2	0.97*	6.2	1.58*
39	0.6	0.50	0.7	1.00*	0.5	0.80*	0.4	(-3.50)
40	0.6	(-1.50*)	0.5	(-1.80*)	0.6	(-1.67*)	0.9	(-0.89)
41	1.1	1.18*	1.2	1.46*	0.9	1.11*	0.4	1.75*
42	1.8	1.11*	2.3	1.30*	1.3	1.00*	0.6	1.17*

[a] $w_i = p_i q_i / m_f$.

[b] $\eta_{im} = \beta_i / w_i$.

*The coefficients were significant at the 5 percent level.

Table C-10. Percentage of budget shares ($100\ w_i$)[a] and expenditure elasticities (η_{im})[b], by residential (urbanization) groups, western region

Food code	Region		Urban		Rural nonfarm		Rural farm	
	$100\ w_i$	η_{im}	$100\ w_i$	η_{im}	$100\ w_i$	η_{im}	$100\ w_i$	η_{im}
				Beef				
1	8.2	1.57*	8.2	1.54*	7.6	1.13*	10.5	1.73*
2	4.2	1.12*	4.2	0.95*	3.5	1.06	6.6	1.56*
3	4.8	1.27*	4.8	1.27*	3.0	0.70*	9.4	0.98
4	7.2	1.42*	7.9	1.49*	2.6	1.23	4.4	1.23
5	5.6	1.05*	5.4	1.04*	6.9	1.13*	5.8	1.12
6	1.2	0.75*	1.1	0.54*	1.5	0.93	2.2	1.32*
7	1.6	0.63*	1.4	0.57*	2.8	0.71	1.9	0.42
8	3.1	0.81*	3.1	0.84*	3.2	0.66*	2.1	0.86
9	1.0	0.60*	1.1	0.73*	0.6	0.67	0.3	0.33
10	1.3	0.92	1.4	1.00*	0.8	0.62	0.4	0.75
11	6.2	1.42	5.6	1.43*	10.2	1.45*	9.1	0.92
12	1.0	0.70*	0.9	0.67*	1.6	0.94	1.6	0.62
13	0.4	0.75*	0.3	0.67*	1.3	0.61	0.6	1.17
				Pork				
14	4.4	1.34*	4.5	1.40*	4.7	0.98*	2.9	1.52
15	0.9	0.56*	1.0	0.60*	0.3	0.33	0.5	0.20
16	0.9	0.44*	0.9	0.56*	0.6	0.33	0.4	0.75
17	1.5	1.20*	1.4	1.00*	2.0	1.30	2.6	1.38
18	2.1	0.86*	2.1	0.86*	2.0	0.60*	1.9	0.89
19	4.7	1.13*	4.8	1.15*	4.6	0.83	4.1	1.22
20	5.3	1.19	5.1	0.96	6.7	1.69*	5.8	1.98
21	0.1	(-5.00)	0.1	(-3.00)	0.1	(-16.00)	0.0	$-\infty$
22	0.9	0.78*	0.8	0.75	0.9	0.56*	1.4	1.14*
23	1.1	0.64*	1.1	0.54*	1.1	0.64	1.4	0.64
				Veal				
24	0.5	0.40*	0.6	0.50*	0.1	0.00	0.3	1.00
25	0.00	0.00	0.0	0.00	0.0	0.00	0.0	0.00
26	0.1	0.10*	0.1	0.00	0.0	0.00	0.1	0.00

Table C-10 (Continued)

Food code	Region: $100\ w_i$	Region: η_{im}	Urban: $100\ w_i$	Urban: η_{im}	Rural nonfarm: $100\ w_i$	Rural nonfarm: η_{im}	Rural farm: $100\ w_i$	Rural farm: η_{im}
Lamb								
27	1.4	1.00*	1.7	1.00*	0.0	0.00	0.4	0.50
28	1.0	0.50*	1.0	0.50*	0.3	1.00	0.2	1.00
29	0.1	(-22.00)	0.1	(-26.00)	0.4	(-6.00)	0.0	0.00
Variety meats								
30	1.1	(-12.64*)	1.2	(-11.83*)	0.1	(-33.00)	0.9	(-22.00)
31	0.4	(-2.25)	0.4	(-1.75)	0.1	(-49.00)	0.2	0.50
Lunch meats								
32	3.2	1.47*	3.2	1.50*	3.3	1.21*	2.9	1.52
33	1.0	0.80*	0.9	0.78*	1.3	1.00*	0.7	1.14
34	4.6	1.63*	4.5	1.64*	5.8	1.34*	4.4	1.73
Poultry								
35	10.1	1.71*	10.0	1.76*	11.3	1.57*	8.9	1.72
36	1.2	(-1.08)	1.2	(-0.50)	1.6	0.56	0.2	(-33.00)
37	0.1	1.00	0.1	0.10*	0.0	0.00	0.5	1.00
Fish								
38	2.5	1.08*	2.4	1.21*	2.9	0.76*	1.9	1.05
39	0.8	0.63*	0.9	0.67*	0.5	0.60	0.5	0.40
40	0.3	(-2.33*)	0.3	(-2.33*)	0.5	0.40	0.5	(-2.60)
41	2.1	1.43*	2.1	1.57*	2.5	1.08*	1.2	1.42
42	1.6	1.06*	1.7	1.18*	1.1	0.82	0.5	1.2*

[a] $w_i = p_i q_i / m$.

[b] $\eta_{im} = \beta_i / w_i$.

*The coefficients were significant at the 5 percent level.

Table C-11. Value of 100 R^2 and significance levels of F-tests of regression function, and effects of regions (β_j), residence (urbanization) (α_i), interaction (γ_{ij}), and the residual meat expenditure ($m_f(2)$) as a covariate[a]

Food code	Value of 100 R^2	Significance probability level in percent				
		$R(2)$	β_j	α_i	γ_{ij}	$m_f(2)$[b]
Beef						
1	50.7	0.01	0.52	0.01	--	0.01
2	32.8	0.03	--	--	2.47	0.01
3	34.2	0.02	--	0.03	--	0.01
4	66.3	0.01	0.02	0.01	0.74	0.01
5	40.7	0.01	2.14	1.87	--	0.01
6	14.0	--	--	--	--	--
7	36.2	0.01	--	--	0.31	--
8	23.5	1.18	--	--	--	0.07
9	13.8	--	--	--	--	(--)
10	25.9	0.45	--	2.79	--	0.28
11	46.1	0.01	0.01	--	0.02	0.01
12	15.3	--	--	--	--	--
13	10.7	--	--	--	--	(--)
Pork						
14	51.5	0.01	4.53	0.02	--	0.01
15	7.9	--	--	--	--	(--)
16	50.7	0.01	0.26	--	2.97	0.01
17	19.4	--	0.35	--	--	--
18	19.8	4.77	--	--	--	2.22
19	56.8	0.01	0.01	1.30	2.83	0.01
20	25.2	0.61	0.13	--	--	--
21	61.8	0.01	0.01	0.03	0.01	(--)
22	25.7	0.05	0.67	--	--	0.60
23	14.9	--	--	--	--	2.49
Veal						
24	68.7	0.01	0.01	0.01	0.01	1.19
25	33.3	0.02	--	3.34	--	0.79
26	22.5	1.73	--	--	--	1.29
Lamb						
27	46.8	0.01	0.83	0.17	0.25	2.84
28	35.7	0.01	--	0.71	2.95	--
29	8.8	--	--	--	--	(--)
Variety meats						
30	48.5	0.01	--	0.01	0.62	(--)
31	13.6	--	--	--	--	(1.74)

Table C-11 (Continued)

Food code	Value of 100 R^2	Significance probability level in percent				
		$R^{(2)}$	β_j	α_i	γ_{ij}	$m_f^{(2)b}$
Lunch meats						
32	14.0	--	--	--	--	0.49
33	16.0	--	2.68	--	--	--
34	50.1	0.01	0.76	--	--	0.01
Poultry						
35	46.7	0.01	3.12	--	--	0.01
36	23.3	1.28	--	--	--	(0.01)
37	20.3	3.95	--	--	3.10	--
Fish						
38	70.9	0.01	0.01	0.39	0.01	--
39	24.6	0.76	--	--	1.83	(--)
40	17.5	--	1.11	--	--	--
41	44.7	0.01	4.20	0.28	2.78	0.03
42	29.6	0.10	3.52	2.90	--	3.14

[a] Coefficient not significant is indicated by -- .

[b] Parentheses denote that the sign of the coefficient is negative.

Table C-12. Parameter estimates of analysis of covariance model with residual expenditure as a covariate for 42 meat products[a]

Food code / Parameters[b]	Beef				
	1	2	3	4	5
μ	0.3942**	-0.0196	0.1102	0.0136	0.03526**
b	0.0612**	0.0420**	0.0421**	0.0737**	0.0351**
α_1	0.1142*	0.0366	-0.0279	0.3681**	0.0219
α_2	-0.2921**	-0.0726	-01802**	-0.2462**	-0.1235**
α_3	(0.1779)	(0.0360)	(0.2081)	(-0.1219)	(0.1016)
β_1	-0.2690	0.0104	-0.0983	0.3481**	-0.0095
β_2	0.0728	-0.0567	0.0063	-0.2898**	0.1458**
β_3	0.0286	-0.0438	0.0138	-0.1165	-0.0377
β_4	(0.1676)	(0.0901	(0.0782)	(0.0582)	(-0.1046)
γ_{11}	0.0337	0.1747	0.0516	0.4172**	-0.1134
γ_{12}	-0.0483	-0.1473	-0.0554	-0.2975	0.0202
γ_{13}	0.0846	0.1606	0.0781	-0.0863	0.1323*
γ_{14}	(0.0700)	(-0.1880)	(-0.0743)	(-0.0334)	(-0.0391)
γ_{21}	0.2429*	0.0193	0.0838	-0.1609	0.0924
γ_{22}	-0.0726	0.0625	0.0806	0.2106	-0.1291
γ_{23}	-0.0305	-0.0581	-0.0584	0.0543	-0.0309
γ_{24}	(0.1398)	(-0.0237)	(-0.1060)	(-0.1040)	(0.0676)
γ_{31}	(0.2766	(-0.1940)	(-0.1354)	(-0.2563)	(0.0210)
γ_{32}	(0.1209)	(0.0848)	(-0.0252)	(0.0869)	(0.1089)
γ_{33}	(-0.0541)	(-0.1025)	(-0.0449)	(0.0320)	(-0.1014)
γ_{34}	(-0.3434)	(0.2117)	(0.2055)	(0.1374)	(-0.0285)

Table C-12 (Continued)

Parameters \ Food code	Beef 6	7	8	9	10
μ	0.0315	-0.0760**	0.0190	0.0252	0.0005
b	0.0043	0.0026	0.0202**	-0.0051	0.0070**
α_1	-0.0069	0.0389*	0.0358	0.0182	0.0330**
α_2	-0.0083	-0.0242	-0.0583	-0.0325	-0.0612
α_3	(+0.0152)	(-0.0147)	(0.0255)	(0.0143)	(-0.0168)
β_1	0.0006	0.0535*	-0.0409	0.0108	0.0051
β_2	-0.0028	-0.0302	0.0525	-0.1102*	0.0018
β_3	-0.0320*	-0.0276	-0.0215	0.0537	-0.0162
β_4	(0.0342)	(0.0043)	(0.0099)	(0.0457)	(0.0093)
γ_{11}	0.0256	0.1192**	0.0301	0.0700	-0.0162
γ_{12}	0.0009	-0.0598*	0.0394	-0.1118	0.0005
γ_{13}	0.0151	-0.0028	-0.0519	0.0058	-0.0199
γ_{14}	(-0.0409)	(-0.0566)	(-0.0176)	(-0.0360)	(-0.0311)
γ_{21}	0.0031	-0.0532	-0.0159	-0.0629	0.0021
γ_{22}	-0.0181	0.0141	-0.0194	0.0086	0.0116
γ_{23}	0.0006	0.0206	-0.0027	0.0428	-0.0143
γ_{24}	(0.0144)	(0.0185)	(0.0380)	(0.0115)	(0.0006)
γ_{31}	-0.0288	(-0.0660)	(-0.0142)	(-0.0071)	(0.0141)
γ_{32}	(0.0180)	(0.0457)	(-0.0200)	(0.0132)	(-0.0166)
γ_{33}	(-0.0157)	(-0.0178)	(0.0546)	(-0.0486)	0.0342
γ_{34}	(0.0265)	(0.381)	(-0.0204)	(-0.0475	(-0.0317)

Table C-12 (Continued)

Parameters \ Food code	Beef 11	Beef 12	Beef 13	Pork 14	Pork 15
μ	0.1387	0.0569	0.0332*	0.2148*	0.0419
b	0.1261**	0.0014	-0.0011	0.0380**	-0.0047
α_1	-0.2172	-0.0225	0.0117	0.1413**	0.0408
α_2	0.1437	0.0056	-0.-208	-0.1244**	-0.0166
α_3	(0.0735)	(0.0169)	(0.0091)	(-0.0169)	(-0.0242)
β_1	0.0487	-0.0751*	-0.0127	-0.0213	0.0029
β_2	0.7057**	0.0336	-0.0028	0.0157	-0.0516
β_3	0.2225	0.0254	0.0103	0.1012**	0.0357
β_4	(-0.9769)	(0.0161)	(0.0052)	(-0.0956)	(0.0130)
γ_{11}	-0.3411	0.0703	0.0062	0.1132	0.0025
γ_{12}	-0.6050*	-0.0539	-0.0050	-0.0170	0.0497
γ_{13}	0.1958	-0.0153	0.0121	-0.0493	-0.0517
γ_{14}	(0.7503)	(-0.0011)	(-0.0133)	(-0.0133)	(-0.0005)
γ_{21}	-0.1831	0.0421	-0.0465	0.0281	-0.0221
γ_{22}	-0.2200	0.0024	0.0095	0.0127	0.0276
γ_{23}	-0.4136	-0.0208	0.0078	-0.0816	0.0045
γ_{24}	(0.8167)	(0.0237)	(0.0292)	(0.0408)	(-0.0100)
γ_{31}	(0.5242)	(-0.1124)	(0.0403)	(-0.1413)	(0.0196)
γ_{32}	(0.8250)	(0.0515)	(-0.0045)	(0.0043)	(-0.0773)
γ_{33}	(0.2178)	(0.0361)	(-0.0199)	(0.1309)	(0.0472)
γ_{34}	(-1.5670)	(0.0248)	(-0.0159)	(0.0061)	(0.0105)

Table C-12 (Continued)

Parameters \ Food code	Pork 16	17	18	19	20
μ	-0.0163	0.1587**	-0.1791	0.3160**	0.4489*
b	0.0096**	0.0108	0.0320*	0.0583**	0.0431
α_1	0.0251*	-0.0431	-0.0714	0.0938**	-0.0105
α_2	-0.0175	-0.0244	-0.1175	-0.1422**	-0.0902
α_3	(-0.0076)	(0.0675)	(0.1889)	0.0484	(0.1007)
β_1	0.0040	-0.0440	-0.0723	0.1292*	-0.3519*
β_2	0.0454**	-0.0770	0.1315	0.0344	-0.1444
β_3	-0.0300*	0.1631**	-0.1590	0.1466**	0.6204**
β_4	(-0.0194)	(-0.0421)	(0.0998)	(-0.3082)	(-0.1241)
γ_{11}	0.0206	0.1327*	-0.0562	0.1741*	-0.1943
γ_{12}	0.0470**	-0.0584	0.0200	-0.1454*	0.4382*
γ_{13}	-0.0358*	-0.0485	-0.0080	0.0647	0.0889
γ_{14}	(-0.0318)	(-0.0258)	(0.0442)	(-0.0934)	(-0.3328)
γ_{21}	0.0116	-0.0673	0.0895	0.0436	0.1863
γ_{22}	-0.0250	0.0732	0.0643	0.1042	-0.2075
γ_{23}	-0.0030	-0.0084	-0.2546*	-0.2100*	-0.1098
γ_{24}	(0.0164)	(0.0025)	0.1008	(0.0622)	(0.1310)
γ_{31}	(0.0322)	(-0.0654)	(-0.0335)	(-0.2177)	(0.0080)
γ_{32}	(-0.0220)	(-0.148)	(-0.0843)	(0.0412)	(-0.2307)
γ_{33}	(0.0388)	(0.0569)	(0.2626)	(0.1453)	(0.0209)
γ_{34}	(-0.0490)	(0.0233)	(-0.1448)	(-0.0312)	(0.2018)

Table C-12 (Continued)

Food code / Parameters	Pork 21	Pork 22	Pork 23	Veal 24	Veal 25
μ	-0.2405**	0.0035	0.0375*	0.0198	-0.0011
b	-0.0066	0.0091**	0.0048*	0.0057*	0.0006**
α_1	0.0450	0.0160	0.0022	0.0615**	0.0033**
α_2	0.1373**	-0.0380*	-0.0053	-0.0302*	0.0017
α_3	(-0.1823)	(0.0220)	(0.0031)	(-0.0313)	(-0.0050)
β_1	0.1504**	-0.0116	-0.0130	0.1034**	0.0021
β_2	-0.0341	-0.0510*	0.0094	-0.0389**	0.0016
β_3	-0.3373**	0.0632**	0.0127	-0.0251	-0.0014
β_4	(0.2210)	(-0.0006)	(-0.0091)	(-0.0394)	(-0.0023)
γ_{11}	-0.0282	0.0067	-0.0040	0.1359**	0.0047*
γ_{12}	0.0885	0.0463	0.0298	-0.0382	0.0020
γ_{13}	-0.0580	-0.0016	-0.0198	-0.0337	-0.0030
γ_{14}	(-0.0023)	(-0.0514)	(-0.0056)	(-0.0640)	(-0.0037)
γ_{21}	-0.1314	0.0236	0.0153	-0.0465	-0.0020
γ_{22}	-0.0443	-0.0339	-0.0139	0.0182	-0.0011
γ_{23}	0.3506**	-0.0140	0.0144	0.0046	0.0013
γ_{24}	(-0.1749)	(0.0243)	(-0.0158)	(0.0237)	(0.0018)
γ_{31}	(0.1596)	(-0.0303)	(-0.0113)	(-0.0113)	(-0.0027)
γ_{32}	(-0.0442)	(-0.0124)	(-0.0159)	(0.0200)	(-0.0009)
γ_{33}	(-0.2926)	(0.0156)	(0.0054)	(0.0291)	(0.0017)
γ_{34}	(0.1772)	(0.0271)	(0.0218)	(0.0403)	(0.0019)

Table C-12 (Continued)

Parameters \ Food code	Veal	Lamb			Variety meat
	26	27	28	29	30
μ	0.0001	0.0005	0.0059	-0.0367	-0.0122**
b	0.0004*	0.0058*	0.0017	-0.0047	-0.0238
α_1	0.0016	0.0526**	0.0147**	-0.0813	-0.4858**
α_2	-0.0013	-0.0291	-0.0048	0.0211	0.5876**
α_3	(-0.0003)	(-0.0230)	(-0.0099)	(0.0602)	(-0.1018)
β_1	0.0015	0.0510**	0.0110	0.0468	-0.2044
β_2	0.0002	-0.0411*	-0.0123*	-0.0051	0.0297
β_3	-0.0015	-0.0272	-0.0042	0.0307	0.0734
β_4	(-0.0003)	(0.0173)	(0.0055)	(0.0724)	(-0.1013)
γ_{11}	0.0014	0.0923**	0.0258**	0.0277	-0.5409**
γ_{12}	0.0001	-0.0628**	-0.0133	-0.0646	0.2721*
γ_{13}	-0.0003	-0.0523*	-0.0152*	0.1233	0.0564
γ_{14}	(-0.0012)	(0.0228)	(0.0027)	(-0.0864)	(0.2124)
γ_{21}	0.0004	-0.0371	-0.0098	0.0175	0.3088
γ_{22}	0.0004	0.0312	0.0047	0.0541	-0.3298*
γ_{23}	-0.0004	0.0226	0.0077	-0.0866	-0.1946
γ_{24}	(-0.0004	(-0.0167)	(-0.0026)	(0.0150)	(0.2156)
γ_{31}	(-0.0018	(-0.0552)	(-0.0160)	(-0.0452)	(0.2321)
γ_{32}	(-0.0005)	(0.0316)	(0.0086)	(0.0105)	(0.0577)
γ_{33}	(0.0007)	(0.0297)	(0.0075)	(0.0367)	(0.1382)
γ_{34}	(0.0016)	(-0.0061)	(-0.0001)	(-0.0020)	(-0.4280)

Table C-12 (Continued)

Parameters \ Food code	Variety meat 31	Lunch meats 32	Lunch meats 33	Lunch meats 34	Poultry 35
μ	0.0695	0.1052	0.0511	0.3782**	-2.1524**
b	-0.0383*	0.0455**	0.0005	0.0596**	0.3792**
α_1	0.0702	-0.0791	0.0175	0.1206*	-0.5611
α_2	0.0274	0.0044	-0.0179	-0.0665	0.6229
α_3	(-0.0976)	(0.0747)	(0.0004)	(-0.0541)	(-0.0618)
β_1	0.0505	0.0007	-0.0104	0.0992	0.0661
β_2	-0.0366	0.0667	-0.0549*	0.1878**	-0.0695
β_3	-0.0343	0.0070	0.0539*	-0.1061	-1.0259*
β_4	(0.0204)	(-0.0744)	(0.0114)	(-0.1809)	(1.0293)
γ_{11}	0.1558	-0.2293	-0.0142	0.0361	-0.1969
γ_{12}	-0.1724	0.0528	0.0338	0.0740	0.7282
γ_{13}	-0.0795	0.1191	-0.0103	-0.0062	-0.4985
γ_{14}	(0.0961)	(0.0574)	(-0.0093)	(0.1039)	(0.0328)
γ_{21}	-0.0627	0.1862	0.0263	0.2277	-0.8640
γ_{22}	0.0849	-0.0255	-0.0792*	-0.0499	0.1462
γ_{23}	0.2731	-0.0937	0.0327	0.1434	1.2159*
γ_{24}	(-0.2953)	(-0.0670)	(0.0202)	(-0.0344)	(-0.4981)
γ_{31}	(-0.-931)	(0.0431)	(-0.0121)	(-0.2638)	(1.0609)
γ_{32}	(0.0875)	(-0.0273)	(0.0454)	(-0.0241)	(-0.8744)
γ_{33}	(-0.1936)	(0.0254)	(0.0224)	(0.1496)	(-0.7174)
γ_{34}	(0.1992)	(0.0096)	(-0.0109)	(0.1383)	(0.5309)

Table C-12 (Continued)

Parameters \ Food code	Poultry 36	Poultry 37	Fish 38	Fish 39	Fish 40
μ	0.3076*	0.0016	0.3104**	-0.0156	-0.073**
b	-0.0676**	0.0005	0.0035	-0.0086	0.0010
α_1	-0.0042	-0.0031	0.0622**	0.0853	-0.0146
α_2	0.1665	-0.0019	-0.0644**	0.1196	0.0304**
α_3	(-0.1623)	(0.0050)	(0.0022)	(0.2049)	(-0.0158)
β_1	-0.0335	-0.0042	0.0044	0.0553	0.0087
β_2	-0.0279	0.0026	-0.1379**	-0.2204*	0.0196
β_3	0.0363	-0.0025	0.2991**	0.0804	-0.0504**
β_4	(0.0251)	(0.1656)	(-0.1656)	(0.0847)	(0.0221)
γ_{11}	-0.2907	0.0043	0.2079**	-0.2440	-0.0215
γ_{12}	0.1384	-0.0049	-0.0957**	0.2879**	0.0040
γ_{13}	-0.0512	0.0051	-0.1376**	-0.0272	0.0281
γ_{14}	(0.2035)	(-0.0045)	(0.0254)	(-0.0167)	(-0.0106)
γ_{21}	0.0942	0.0010	-0.0946**	-0.0101	-0.0068
γ_{22}	-0.1616	0.0054	0.0182	0.2262	-0.0108
γ_{23}	0.0868	-0.0001	0.0571	-0.0797	-0.0095
γ_{24}	(-0.1194)	(-0.0063)	(0.0193)	(0.1364)	(0.0271)
γ_{31}	(0.0965)	(-0.0053)	(-0.1133)	(0.2541)	(0.0283)
γ_{32}	(0.0232)	(-0.0005)	(0.0775)	(-0.5141)	(0.0068)
γ_{33}	(-0.0356)	(-0.0050)	(0.0805)	(0.1069)	(-0.0186)
γ_{34}	(-0.0841)	(0.0098)	(-0.0477)	(0.1531)	(-0.0165)

Table C-12 (Continued)

Parameters \ Food code	Fish 41	Fish 42
μ	0.0304	0.0403
b	0.0143**	0.0092*
α_1	0.0707**	0.0594*
α_2	-0.0131	-0.0100
α_3	(-0.0576)	(-0.0494)
β_1	-0.0018	0.0598
β_2	-0.0343	-0.0691*
β_3	-0.0361	0.0217
β_4	(0.0732)	(-0.0124)
γ_{11}	0.0951**	0.0371
γ_{12}	-0.0673*	-0.0718*
γ_{13}	-0.0263	0.0410
γ_{14}	(-0.0015)	(-0.0063)
γ_{21}	0.0342	0.0149
γ_{22}	0.0063	0.0202
γ_{23}	-0.0226	-0.0313
γ_{24}	(0.0179)	(-0.0038)
γ_{31}	(-0.1293)	(-0.0520)
γ_{32}	(0.0610)	(0.0516)
γ_{33}	(0.0489)	(0.0042)
γ_{34}	(0.0194)	(-0.0038)

[a] Estimates in parenthese are computed using the contraints:

$$\sum_i \alpha_i = \sum_j \beta_j = \sum_i \gamma_{ij} = \sum_j \gamma_{ij} = 0.$$

[b] α indicates residence (urbanization) group and β indicates region; for residence, 1 is urban, 2 is rural nonfarm, and 3 is rural farm; for region, 1 is northeast, 2 is north central, 3 is south, and 4 is west.

* Significant at the 5 percent level.

** Significant at the 1 percent level.

Table C-13. Standarsized β values of parameter estimates in analysis of covariance with residual expenditure as a covariate

Food code	b	α_1	α_2	β_1	β_2	β_3
			Beef			
1	0.52	0.17	-0.42	-0.34	0.10	0.04
2	0.46	0.08	-0.14	0.02	-0.10	-0.08
3	0.51	-0.07	-0.37	-0.18	0.01	0.03
4	0.44	0.42	-0.25	0.31	-0.28	-0.11
5	0.44	0.05	-0.26	-0.02	0.30	-0.08
6	0.21	-0.06	-0.07	0.00	-0.02	-0.25
7	0.08	0.24	-0.13	0.26	-0.16	-0.15
8	0.38	0.13	-0.17	-0.12	0.16	-0.07
9	-0.08	0.05	-0.08	0.02	-0.27	0.13
10	0.32	0.30	-0.13	0.04	0.01	-0.12
11	0.40	-0.13	0.08	0.02	0.37	0.12
12	0.04	-0.13	0.03	-0.33	0.16	0.12
13	-0.06	0.13	-0.21	-0.11	-0.03	0.10
			Pork			
14	0.51	0.37	-0.28	-0.04	0.03	0.22
15	-0.10	0.16	-0.06	0.01	0.17	0.12
16	0.40	0.21	-0.13	0.03	0.31	-0.21
17	0.17	-0.13	-0.07	-0.11	-0.20	0.42
18	0.27	-0.11	-0.16	-0.09	0.17	-0.21
19	0.54	0.17	-0.23	0.18	0.05	0.22
20	0.19	-0.01	-0.07	-0.24	-0.11	0.45
21	-0.07	0.10	0.26	0.25	-0.06	-0.61
22	0.30	0.10	-0.21	-0.06	-0.27	0.34
23	0.26	0.02	-0.05	-0.11	0.08	0.11
			Veal			
24	0.18	0.37	-0.16	0.49	-0.20	-0.13
25	0.27	0.27	-0.12	0.13	0.11	-0.10
26	0.27	0.21	-0.16	0.16	0.03	-0.17
			Lamb			
27	0.20	0.35	-0.17	0.26	-0.23	-0.15
28	0.19	0.33	-0.09	0.19	-0.23	-0.08
29	-0.05	-0.17	0.04	0.08	-0.01	0.05
			Variety meats			
30	-0.13	-0.50	0.54	-0.17	0.03	0.06
31	-0.28	0.10	0.03	0.05	-0.04	-0.04

Table C-13 (Continued)

Food code	b	α_1	α_2	β_1	β_2	β_3
			Lunch meats			
32	0.33	-0.11	0.00	0.00	0.08	0.01
33	0.01	0.11	-0.10	-0.05	-0.28	0.28
34	0.48	0.19	-0.10	0.12	0.25	-0.14
			Poultry			
35	0.55	-0.16	0.15	0.01	-0.02	-0.024
36	-0.045	0.00	0.19	-0.03	-0.03	0.04
37	0.17	-0.20	-0.11	-0.20	0.14	-0.14
			Fish			
38	0.06	0.20	-0.18	0.01	-0.38	0.82
39	-0.06	0.12	0.15	0.06	-0.26	0.09
40	0.05	-0.13	0.24	0.06	0.15	-0.38
41	0.35	0.33	-0.05	-0.01	-0.14	-0.14
42	0.23	0.28	-0.04	0.22	-0.28	0.09

CITED REFERENCES

Alcaly, Roger E. and Alvin K. Klevorick. "Judging Quality by Price Snob Appeal and the New Consumer Theory," Zeitschrift für National Okonomie, 1969.

Barten, A.P. "Consumer Demand Functions Under Conditions of Almost Additive Preferences," Econometrica, 32, pp. 1-38, 1964.

Barten, A.P. "Evidence on the Slutsky Conditions for Demand Equations," Review of Economics and Statistics, 49, pp. 77-84, 1967.

Barten, A.P. "Estimating Demand Equations," Econometrica, Vol. 36, pp. 213-225, 1968.

Barten, A.P. and Turnovsky, S.J. "Some Aspects of Aggregation Problems for Composite Demand Equations,"International Economic Review, Vol. 7, pp. 231-259, 1966.

Becker, G. "A Theory of the Allocation of Time," The Journal of Political Economy, Sept. 1965.

Belli, Pedro. "The Economic Implications of Malnutrition: Dismal Science Revisited," Economic Development and Cultural Change, Vol. 20, October 1971.

Bennett, M.K. and Pierce, R.H. "Change in the American National Diet, 1879-1959," in Food Research Institute of Studies, May, pp. 95-119, 1961.

Bennett, M.K. The World Food. New York: Harper & Row. 1954.

Berg, Alan. "Nutrition as a National Priority: Lesson from India Experiment," American Journal of Clinical Nutrition, Vol. 23, 1970.

Berg, Alan. The Nutrition Factor. Brookings Institution. 1973.

Berg, Alan; Scrimshaw, Nevin S. and Call David L. (Ed.) "Nutrition, National Development, and Planning." Proceedings of International Conference held at Cambridge, Massachusetts, Oct. 19-21, 1971.

Bridge, J. Applied Econometrics. North Holland Publishing Co., 1971.

Brown, J.A.C. "The Consumption of Food in Relation to Household Composition and Income," Econometrica, Vol. 22, 1954.

Bryan, M.S. and Lownberg, M.E. "Father's Influence on Young Children's Preferences," Journal of Am. Diet. Assn., Vol. 34, 1958.

Chetty, K.V. "On Measuring the Nearness of Near-Moneys," The American Economic Review, June 1969.

Correa, H. and Cummins, G. "Contribution of Nutrition to Economic Growth," Am. Journal of Clinical Nutrition, 23, p. 560, 1970.

Cramer, J.S. "Efficient Grouping, Regression and Correlation in Engel Curve Analysis," Journal of American Statistical Association, 59, pp. 233-250, 1964.

De Janvry. "Measurement of Demand Parameters Under Separability," Ph. D. Dissertation, Univ. of California, Berkeley, 1966.

Dubos, R. "Lasting Biological Effects of Early Influences," Perspec. Biol. Med., 12, p. 479, 1969.

Drymes, P.J. "On a Class of Utility and Production Functions Yielding Everywhere Differentiable Demand Functions," Review of Economic Studies, 34, pp. 399-408, 1967.

Farber, S.M.; Wilson, N.L. and Wilson, R.H.L. Food and Civilization: A symposium. Charles C. Thomas Publication, 1966.

Fisher, I. Mathematical Investigations in the Theory of Value and Prices. New Haven: Yale University Press. 1925.

Frisch, R. "A Complete Scheme for Computing all Direct and Cross Elasticities in a Model with Many Sectors," Econometrica, 27, pp. 77-96, 1959.

Forsyth, F.G. "The Relationship Between Family Size and Family Expenditure," Journal of the Royal Statistical Society, A, 123, pp. 327-397, 1960.

Geary, R.C. "A Note on the Constant Utility Index of the Cost of Living," Review of Economic Studies, 18, pp. 65-66, 1949-50.

Gifft, H.H.; Washbon, M.B. and Harrison, G.G. Nutrition, Behavior and Change. Prentice-Hall: Englewood Cliffs, N.J. 1972.

Goldberger, A.S. "Direct Additive Utility and Constant Marginal Budget Shares," Social Research Systems Research Institute, Univ. of Wisconsin Workshop Paper, No. 6705, 1967a.

Goldberger, A.S. "Functional Form and Utility. A Review of Consumer Demand Theory," Social Research Systems Research Institute, University of Wisconsin Workshop paper No. 6307, 1967b.

Goldberger, A.S. "A Cross-Country Comparison of Consumer Expenditure Patterns," European Economic Review, pp. 357-400, 1967c

Hicks, J.R. Revision of Demand Theory. Oxford. 1956.

Hicks, J.R. and Allen, R.G. "A Reconsideration of Theory of Value," Economica, New Series I, Feb., 1934, pp. 52-76 and 196-219, 1934.

Houthakker, H.S. "An International Comparison of Household Expenditure Patterns Commemorating the Centenary of Engel's Law," Econometrica, 29, 1957.

Houthakker, H.S. "Additive Preferences," Econometrica, 28, pp. 244-257, 1960.

Houthakker, H.S. "The Present State of Consumption Theory," Econometrica, 29, 1961.

Houthakker, H.S. and Taylor, L.D. Consumer Demand in the United States. Harvard University Press, Cambridge. 1966.

Ironmonger, D.S. New Commodities and Consumer Behaviour. Cambridge University Press, 1972.

Jevons, W.S. "The Theory of Political Economy," London: Macmillan, 1871.

Johansen, L. "On the Relationships of Some Systems of Demand Functions," Liiketaloudellinen Aikakauskirja. No. 1, 1969.

Kelley, A.C.; Williamson, J.G.; Cheethan, R.J. Dualitic Economic Development. The University of Chicago Press, Chicago & London. 1972.

Keys, A.; Brozek, J.; Henschel, A.; Mickelsen, O. and Taylor, H.L. The Biology of Human Starvation. 2. University of Minnesota Press, 1950.

Kramer, A. Food and the Consumer. The AVI Pub. Co., Inc., 1973.

Kravis, I.B. "Availability and Other Influences on the Commodity Composition of Trade," Journal of Political Economy, Vol. 64, April, 1956.

Lancaster, K.J. "A New Approach to Consumer Theory," Journal of Political Economy, Vol. LXXIV, pp. 132-157, 1966.

Lancaster, K.J. Consumer Demand: A New Approach. Columbia University Press, 1971.

Linder, S. "An Essay on Trade and Transformation," New York: John Wiley, 1961.

Lowenberg, M.E. Food and Man. New York: John Wiley, 1968.

Madden, J.P. and Yoder, M.D. "Program Evaluation: Food Commodity Distribution in Rural Areas of Central Pennsylvania," Dept. Agr. Econ. A Rural Sociology Penn. St. Univ., 1972.

Marshall, A. Principles of Economics. 8th Ed., Macmillan, Book III, 1953.

Maslow, A.H. "A Theory of Human Motivation," Psychological Review, 50, 1943.

Malenbaum, "Health and Productivity in Poor Areas," in Empirical Studies in Health Economics, ed. by H.E. Klarman and H.H. Jaszi, Johns Hopkins Univ. Press, 1970.

Nicholson, J.L. "Variations in Working Class Family Expenditures," Journal of Royal Statistical Society, Series A (General), Vol. 112, 1949.

Pareto, V. "Considerazioni sui Principii Fondamentali dell," Economica Politica Para Giornall degli Econo misti., Vol. V, 1892.

Pareto, V. Manuel d'Economie Politique. Paris: V. Giard & E. Briere, 1909.

Parks, R.W. "Systems of Demand Equations: An Empirical Comparison of Alternative Functional Forms," Econometrica, 37, pp. 629-650, 1969.

Paroush, J. "Consumption Technology and Order Relations in Consumption," Ph.D. Dissertation, Columbia University, 1969.

Paul, R.C. "Nutrition and Stress" in Food and Civilization, ed. by Farber, Wilson and Wilson, Charles C. Thomas Publisher, 1966.

Pearce, I.F. A Contribution to Demand Analysis. Oxford: Clarendon Press, 1964.

Posner, M.V. "International Trade and Technological Change," Exford Economic Papers, Oct. 1961.

Powell, A.A. "A Complete System of Consumer Demand Functions for the Australian Economy Fitted by Model of Additive Preferences," Econometrica, Vol. 34, pp. 661-675, 1966.

Praag Van, M.S. Individual Welfare Functions and Consumer Behavior. North Holland Publ. Co., 1968.

Prais, S.L. and Houthakker, H.S. Analysis of Family Budgets. Cambridge Univ. Press, 1955.

Pyke, M. Food and Society. London: John Murray, 1968.

Roy, J.K. "A Social Custom Associated with the Feeding Practice Profoundly Affecting the Protein Intake," Proceedings of the Nutrition Society of India, No. 6, 1968.

Scitovsky, T. Welfare and Competition. Irwin Inc., 1951.

Scrimshaw, N. and Cordon C.E. (ed.) "Malnutrition, Learning and Behavior," M.I.T. Press, 1968.

Slutsky, E. Sulla teoria del bilancio del consummatore," Geiornale degli Economisti, 51, pp. 1-26. (Reprinted in an English translation by Olga Ragusa, as "On the Theory of the Budget of the Consumer," in AEA Reading in Price Theory, Richard Irwin, Chicago, 1952.

Stigler G. "The Economies of Information," Journal of Political Economy, Vol. 69, p. 224, June 1961.

Stone, R. "Linear Expenditure Systems and Demand Analysis: An Application to the Pattern of British Demand," Economic Journal, 64, 1954.

Theil, H. "The Information Approach to Demand Analysis," Econometrica, 33, pp. 67-87, 1965.

Theil, H. Lectures on Econometrics. Center for Mathematical Studies in Business and Economics, University of Chicago, 1967.

Theil, H. Principles of Econometrics. John Wiley & Sons, 1971.

Theil, H. and Neudecker, H. "Substitution, Complementarity and Residual Variation Around Engel Curves," Review of Economic Studies, Vol. XXV, 1958.

Thomas, W.J. (ed.) The Demand for Food. Manchester Univ. Press, 1972.

Tsujimura, K. "Family Budget Data and Market Analysis," Bulletin de l'Institute International de Statistique, Vol. XXXVIII, pp. 215-242, 1960.

Tsujimura, K. and Sato, T. "Irreversibility of Consumer Behavior in Terms of Numerical Preference Fields," Review of Economics and Statistics, XLVI, pp. 305-319, 1964.

U.S.D.A. Household Food Consumption Survey Reports. Washington: U.S.D.A., No. 1-17, 1965.

Vernon, R. "International Investment and International Trade in the Product Cycle," Quarterly Journal of Economics, 1966.

Winick, M. "Nutrition and Cell Growth," Nutrition Review, 26, p. 195, 1968.

Zaltman, G. Marketing Contributions from the Behavioural Sciences, New York: H. B. & World, 1965.

Zellner, A. "An Efficient Method of Estimating Seemingly Unrelated Regressions and Tests for Aggregation Bias," Journal of American Statistical Association, 57, pp. 348-368, 1962.

ADDITIONAL REFERENCES

Atkins, M.H. "An Econometric Analysis of the Consumption of Oranges in the United Kingdom." Bulletin 128, Department of Agricultural Economics, University of Manchester. 1969.

Berg, Alan. "Malnutrition and National Development," Foreign Affairs, Oct., 1967.

Berg, Alan. "Trends Towards Survival, Nutrition and Population Dilemma," Interplay, Feb., 1970.

Berg, Alan. "Increased Income and Improvement Nutrition:A Shibboleth Examined," International Development Review, Vol. 12, 1970.

Berg, Alan. "Priority of Nutrition in National Development," Nutrition Review, Vol. 28, Aug., 1970.

Berg, Alan and Muscat, Robert. "Macro-Nutrition," Paper presented at the Western Hemisphere Nutrition Conference,Bal Harbour, Fla., 1971.

Berg, Alan and Muscat, Robert. "Nutrition Program Planning: A Conceptual Approach," Paper presented at the International Conference of Nutrition, National Development and Planning, Cambridge, Mass.

Berg, Alan and Muscat, Robert. "Nutrition and Development: View of the Planner," Paper prepared for the May 3-7, 1971 meeting of the Secretary General's Panel to formulate a United Nations Strategy Statement on the Protein Problem confronting the developing countries.

Brown A. and Deaton A. "Surveys in Applied Economics: Models of Consumer Behavior," Economic Journal, Dec., 1972.

Brown, K.H. "Social Class Family Investment," Unpublished Ph.D. Dissertation. Cornell University, Ithaca. 1968.

De Oliveria, J.E. "Development of Protein Foods in Brazil," U.N. Protein Advisory Group Meeting, New York, Oct., 1967.

Dupont J. (ed.) "Dimensions of Nutrition." Colorado Associated University Press. 1970.

Goeux, L.M. "Income and Food Consumption." Monthly Bulletin of Agricultural Economics and Statistics, F.A.O., Rome, 1960.

Lesser, C.E.V. "Forms of Engel Functions," Econometrica, 31, pp. 694-703, 1963.

Levenson, J.F. "Morinda: An Economic Analysis of Malnutrition Among Young Children in Rural India," Cornell/MIT International Nutrition Policy Series, 1974.

Mather, L.L. (ed.) Economics of Consumer Protection. The Interstate Printers & Publishers, Inc. Danville, Ill. 61832. 1971.

Mayer, J. "Human Nutrition, Its Physiological, Medical and Social Aspects," Charles C. Thomas pub., 1972.

Miah, M.A. Hamid. "A Study of the Demand for Beverages in Great Britain Using National Food Survey Data," Bulletin 130, Department of Agricultural Economics, University of Manchester, 1969.

Miah, M.A. Hamid. "An Econometric Analysis of Demand for Meat in the United Kingdom," Ph.D. Thesis, University of Manchester, 1972.

Polopolus, L. "Synthetic and Substitute Foods Domestic and International Aspects," Agricultural Science Review, Vol. 7, No. 3, 1969.

Polopolus, L. "Changes in Tastes and Preferences: Free Consumer Choice versus Persuasive Marketing Tactics," paper presented before an International Symposium on Synthetic and Substitute Foods, Zurich, Switzerland, Feb. 6, 1970.

Recheigl, M. Jr. Man, Food and Nutrition. CRC Press. 1973.

Sandee, J.(ed.) Europe's Future Consumption, North Holland Pub. Co., 1964.

Schultz, H. The Theory and Measurement of Demand. Chicago, University of Chicago Press. 1938.

Searle, S.R. Linear Models. John Wiley. 1971.

Slater, J.M. "Regional Consumer Expenditure Studies Using National Food Survey Data," Journal of Agricultural Economics, 20, No. 2., 1969.

Southworth, H.M. and Johnson, B.F. (ed.) Agricultural Development and Economic Growth, Cornell Univ. Press. 1967.

Stone, R. (ed.) Mathematics in the Social Sciences and Other Essays, Chapman & Hall. London. 1966.

Summers, R. "A Note on Least Squares Bias in Household Expenditure Analysis," Econometrica 27, 1959.

Williams, C.D. "Malnutrition," Lancet 2, p. 342, 1962.

Wu, S. and Pontney, J. Introduction to Modern Demand Theory. New York: Random House, 1968.

BIOGRAPHICAL SKETCH

Jagadev N. Bagali was born August 6, 1932 in Sindgi, a small village in South India. In June 1956, he received the degree of Bachelor of Arts, with honors, in Mathematics from Vijay College, located at Bijapur and affiliated with the Karnatak University, Dharwar, India. For one year he served as a teacher in H.G. High School in Sindgi. In June 1957 he entered Karnatak University where he received the degree of Master of Arts in Statistics in June 1959.

For two years he was a member of the faculty of S.B. College, Gulbarga, India, where he taught statistics and mathematics. He joined the faculty of the Department of Statistics, Karnatak University, as assistant professor in June 1961 and taught graduate courses in statistics and econometrics until August 1970. During this period he also served as supervisor of the data processing unit in the Department of Statistics.

He enrolled in the Graduate School of the University of Florida in September, 1970 and since that time has pursued a program leading to the degree of Doctor of Philosophy with a major in Food and Resource Economics.

The author is a member of the American Agricultural Economics Association, the American Economic Association, the Indian Economic Association, and the Canadian Association for South Asian Studies. He is also a member of Gamma Sigma Delta, an Honor Society in Agriculture.

The author was married in 1961, to the former Laxmi Anigol, and they have three sons.

I certify that I have read this study and that in my opinion it conforms to acceptable standards of scholarly presentation and is fully adequate, in scope and quality, as a dissertation for the degree of Doctor of Philosophy.

A.A. Prato

A.A. Prato, Chairman
Associate Professor of Economics
Colorado State University

I certify that I have read this study and that in my opinion it conforms to acceptable standards of scholarly presentation and is fully adequate, in scope and quality, as a dissertation for the degree of Doctor of Philosophy.

Leo Polopolus, Co-Chairman
Professor and Chairman of
Department of Food and Resource
Economics

I certify that I have read this study and that in my opinion it conforms to acceptable standards of scholarly presentation and is fully adequate, in scope and quality, as a dissertation for the degree of Doctor of Philosophy.

W. W. McPherson

W.W. McPherson
Graduate Research Professor of
Food and Resource Economics

I certify that I have read this study and that in my opinion it conforms to acceptable standards of scholarly presentation and is fully adequate, in scope and quality, as a dissertation for the degree of Doctor of Philosophy.

Howard Appledorf

Howard Appledorf
Associate Professor of Food Science

This dissertation was submitted to the Graduate Faculty of the College of Agriculture and to the Graduate Council, and was accepted as partial fulfillment of the requirements for the degree of Doctor of Philosophy.

June, 1975

Dean, College of Agriculture

Dean, Graduate School